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Énergie, Mines et Ressources Canada
ENERGY POLICY SECTOR

AN ENERGY STRATEGY FOR CANADA: POLICIES FOR SELF-RELIANCE

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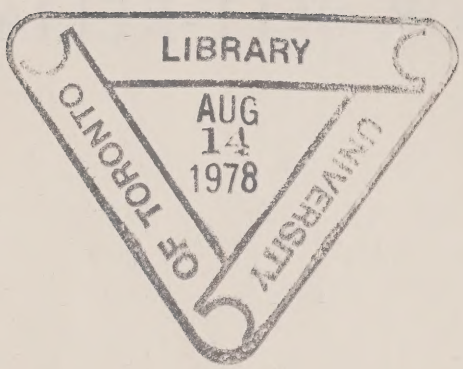

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FOREWORD

Since the summer of 1973, the international energy situation has changed dramatically. The world price of oil has increased from about $2.20 per barrel in the Persian Gulf to $11.50 per barrel. No country has been unaffected.

Canada has been more fortunate than most countries. Because we have domestic oil reserves we have been able to cushion the effects of higher international prices on the Canadian economy and to make the adjustment to higher energy prices easier for individual Canadian consumers. The price of oil in Canada is currently about $4.60 per barrel lower than the price eastern Canadians would have to pay for imported oil if there were no subsidy program. However, proved reserves of Canadian oil and low-cost proved reserves of natural gas are declining. Canada now imports more crude oil than it sells abroad. As well, drilling results in Canada's frontier areas have been relatively disappointing and the recent experience with the Syncrude project indicates that the further development of the oil sands will be extremely expensive. Finding new oil and natural gas reserves, developing them and transporting them to market will now cost substantially more and will require Canadian prices higher than those currently existing.

While our proved reserves of oil and low-cost gas continue to decline, Canadian demands for these energy forms continue to increase. The growing gap between our energy demands and our ability to supply them from domestic reserves suggest that we could become increasingly dependent on the rest of the world, and the Organization of Petroleum Exporting Countries in particular, for our future oil supplies. This prospect carries with it economic and political risks which the Government of Canada views with concern.

We have, within Canada, the people, the equipment, the expertise and the potential energy resources to reduce substantially our dependence on imported oil. We can do this by reducing the rate at which our energy requirements grow in the future, by substituting those energy forms which are in relatively abundant supply in Canada for those that are not, by accelerating the search required to find new oil and natural gas—to convert the potential of our undiscovered energy resources to proved reserves from which our needs can be supplied. All of these options will be expensive, but all must be pursued. The alternatives are energy shortages which will require increasing dependence on high-cost, insecure oil imports or rationing available supplies among Canadians. It is within our power to avoid both of these alternatives and we must act to do so.

This publication outlines a National Energy Strategy for Self-Reliance that the Government of Canada feels is necessary and appropriate, and sets forth a number of specific targets. These targets are ambitious but they can be met by concerted action by governments, with the support and cooperation of all Canadians. They are put forward against a review presented here of the energy policy decisions made since late 1973 and of future energy scenarios that could face Canadians in the period 1976-1990.

The strategy the Government has adopted, it will be seen, involves a number of energy policies which, taken together, provide a comprehensive approach. The elaboration of such policies must look beyond the next ten to fifteen years, and beyond the period when oil and natural gas will supply the bulk of our energy requirements. From time to time, policy papers will be published by the Government in the light of progress in Canada and of international developments. But the next ten years are critical. The problems we face are immediate and to the degree we can resolve them positively and constructively we will increase the options available to us in planning for the longer term.

HONOURABLE ALASTAIR GILLESPIE

Minister of Energy, Mines and Resources

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Section I
INTRODUCTION

> The use of energy, in amounts equal to any reasonable demand, is essential to the attainment of a high quality of life in Canada. It is indispensable to generate the wealth that will enable Canadians to improve their social environment, to protect and enhance their natural environment, and to produce the surplus of goods and services, the range of individual choices and actions, the opportunities for education and intellectual development, the leisure time and the bonds within our society that will enable each of us, according to our interests and values, and all of us together, to improve the quality as well as the prosperity of our living. Our energy policy must make this possible.

The above quotation is taken from a comprehensive study of the Canadian energy situation, its history, prospects and problems, published by the Government of Canada in the summer of 1973*. The Minister of Energy, Mines and Resources wrote, in the foreword to that publication, that "The next step is one of consultation. Consultation with members of the public interested in the various facets of the energy question and with governments of the provinces. On the basis of the information which this report provides as to where we are, and where the various choices may lead us, and following those consultations, the Government of Canada will then reach the second phase of its approach to the energy problem of deciding how, and with what instruments our existing energy policies should be altered."

That was in June of 1973. Barely four months later war broke out in the Middle East and the Organization of Petroleum Exporting Countries (OPEC**) raised substantially the international price of oil. As well, some exporting countries curtailed production and applied a selective embargo against certain importing countries. These actions precipitated what was referred to as the "energy crisis" in the winter of 1973–74. By the spring of 1974 the embargo had been removed, but prices remained high and by the spring of 1975 had increased to a level five times that of 1973.

In 1972, OPEC produced about 27 million barrels of crude oil per day, almost 85% of world imports and 54% of total world crude oil production. The strategic importance of oil, and in particular OPEC oil, in the world economic system can be seen from the fact that in 1972 oil supplied about 55% of total

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* *An Energy Policy for Canada: Phase 1*, vol. 1, Ottawa: Information Canada, 1973, p. 29. This study is referred to as *Phase 1* through this document.

** The *OPEC* was formed by the governments of the main oil-exporting countries in 1960 to resist the decline in prices of crude oil that had been occurring for several years and to formulate common policies in dealing with the relatively few international companies who controlled the trade in oil. Member countries include Algeria, Ecuador, Gabon, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, United Arab Emirates and Venezuela. The Organization of Arab Petroleum Exporting Countries (OAPEC) is a smaller group, comprised of Abu Dhabi, Algeria, Bahrain, Egypt, Iraq, Kuwait, Libya, Qatar, Saudi Arabia and Syria. The selective embargo in the winter of 1973-74 was instituted by the OAPEC rather than the OPEC.

energy requirements in the industrialized countries of the OECD*. Of the total oil consumed by the OECD countries, 64% was imported, the bulk of it from OPEC sources.

Over the past two years, much has been written about the "energy crisis." In the winter of 1973–74, for some countries, because of the embargo, the energy crisis was a crisis of supply. For all countries it has been a crisis of price. Resulting economic pressures have manifested themselves in severe balance-of-payments problems for many countries (and particularly for the developing oil-importing countries), in an acceleration of worldwide rates of inflation that were already abnormally high, and in a marked reduction in real economic activity. But, most fundamentally, it was and remains a crisis of adjustment. The events of the last two years have heightened our awareness of the need to adjust, over the longer term, to new energy systems that will prove to be sustainable. They have also emphasized the necessity, over the shorter term, of making the adjustment to new energy circumstances in a manner that imposes the minimum possible burden on Canadians and preserves the balance and flexibility necessary in an uncertain world.

We are living in a world where past behaviour, while it provides a useful guide to future prospects, does not in itself provide sufficient information on which to base future energy policies. Energy supply projects are now so big and so expensive that one requires a much more precise recognition of the interrelationships between energy-policy planning and other social and economic goals than was necessary in the past. There are a number of key questions:

What will happen to international oil prices in the future?

What will be the effect of higher oil prices on the prices of natural gas, coal, electricity?

Over what time frame, and to what degree, will higher energy prices lead to slower rates of growth in energy demand?

How will higher energy prices impact on our industry and its competitive position?

To what degree can active energy conservation policies further limit the increase in demand, and at what costs?

Does Canada have the resource base to supply all of its domestic requirements?

How will higher prices affect energy supply prospects in Canada and around the world?

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* The *OECD* refers to the Organization for Economic Cooperation and Development. The member countries are Australia, Austria, Belgium, Canada, Denmark, Finland, France, the Federal Republic of Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States.

New energy supplies in Canada will be extremely expensive, requiring much more labour and capital than has previously been used to find and produce energy. If we accelerate the development of these additional high-cost supplies where will we obtain the labour and capital? What will be the environmental and social implications? What will we, as Canadians, have to give up in return?

It is essential to have reasonably reliable answers to these questions in order to develop appropriate national energy policies. But it is also important to realize that we are dealing in probabilities, not certainties. These questions, are not easily answered. And the most fundamental question is the most difficult: what will happen to international oil prices in the future? Is the current world price for oil sustainable or will we see, as we have seen time and again in the case of other commodities, a decline in oil prices as new sources of supply are encouraged and demands slacken in response to high prices? If this should occur, will Canadians be left with high-cost, domestic energy sources?

For the past two years, the Department of Energy, Mines and Resources has been engaged in assessing the implications of a markedly different international energy environment for Canadian energy supply and demand prospects. This assessment has been cast in a broad context, in an attempt to make appropriate allowance for the uncertainties that continue to face energy policy planning, and to take due account of the interrelationships among energy objectives and other social and economic objectives of Canadians. This publication presents both a current assessment of energy prospects and problems to 1990 and a strategy for dealing with them.

This analysis deals essentially with the next fifteen years, the period 1976–1990. It is clear that over the longer term our energy systems will have to adjust in a manner that reduces dependence on hydrocarbon energy sources that are limited in their supply. Hydrocarbons in the earth's crust represent energy capital that has been accumulated over millions of years. We are currently consuming that capital at a high rate and the time will come when it will run out. When that occurs we will have to rely on energy sources that hold the promise of being virtually limitless. Hydroelectric power is currently the most important renewable energy resource in Canada. Although technology exists that will allow the utilization of other renewable energy resources (for example, solar, wind, tidal power) it has not been developed to the point where it is commercially practicable on a large scale. In particular areas or in specific applications some scope exists for the use of such renewable energy resources, particularly as supplementary energy sources. But, in general, the use of these energy sources on the scale needed over the longer term will require the further development of technologies that are likely, for the most part, to be quite expensive. A limited amount of basic research and development is now taking place, but it must be accelerated.

It must be recognized that the development of such alternative energy sources can contribute relatively little in terms of total energy supply over the next fifteen years. Indeed, the premature replacement of lower-cost hydro-

carbon energy by higher-cost alternatives could impose unnecessary burdens on Canadians. What is necessary is to begin now to plan so that such a transition can take place in as smooth and orderly a manner as possible. These longer range issues will be addressed in a paper to be published later that will deal with alternative energy futures beyond 1990.

The present publication presents an overview of the prospective energy situation and outlines the approach that the Government of Canada will pursue in dealing with it. The focus, to a large degree, is on oil and natural gas which currently account for about 65% of total Canadian energy consumption and will continue to be the single most important energy source for the next fifteen years. The energy problems we are facing result largely from extremely rapid and substantial increases in international oil prices and the risks of an interruption of supply as we and other consuming nations become increasingly dependent on foreign oil producers. The decisions we will have to make in the next few years will be influenced to a large extent by our future domestic prospects with regard to oil and natural gas.

The analysis presented here has been prepared against a background that is dynamic and continuing to evolve. It will continue to be updated as the current uncertainties that characterize international energy markets and domestic energy prospects become clearer. This publication provides a context in which Canadian energy problems and policies can be understood and indicates the directions in which our energy policies must continue to be developed. It will be supplemented and extended by a number of further studies and policy papers that will examine specific energy problems, individual energy commodities, and alternative energy futures.

The future is uncertain. Supply/demand scenarios presented in Section III, which are based on a number of alternative assumptions, suggest that our capability to meet anticipated energy demands over the period 1976–1990, in a manner that protects and enhances our standard of living and the quality of our life, will require new initiatives on the part of all Canadian governments, increased activity by the private sector, and new attitudes towards energy use by the consuming public. The scenarios suggest that over the next ten years our dependence on imported oil could increase, to the point where net oil imports may be required to satisfy between 40 and 47% of our oil demands by 1985. As our imports increase, our reliance on sources of supply that may be insecure will increase as well. This prospect carries with it substantial economic and political risks that we must work to minimize.

The National Energy Strategy for Self-Reliance adopted by the Government of Canada and described in Section IV is directed at minimizing these risks by minimizing our dependence on imported oil. The objective of the strategy is to achieve energy self-reliance. Self-reliance in energy means reducing our vulnerability. It means supplying Canadian energy requirements as much as possible from domestic resources. It involves a two-pronged approach: first, to reduce our oil imports to the greatest extent practicable; second, to provide an

adequate degree of emergency preparedness to deal with supply interruptions if they should in fact occur. It recognizes, however, that the policies we will adopt have costs as well as benefits and a balance that provides the maximum advantages to Canadians must be found.

In support of this objective, the federal government has identified a number of policy elements that will be pursued in support of the self-reliance objective: These policy areas, which are elaborated in Chapter 3 of Section IV, are:

- appropriate energy pricing;
- energy conservation;
- increased exploration and development;
- increased resource information;
- interfuel substitution;
- new delivery systems;
- emergency preparedness;
- increased research and development; and
- greater Canadian content and participation.

Finally, on the basis of the scenarios presented in Section III and in support of the objective of the National Energy Strategy, the Government of Canada is adopting the following energy targets:

- moving domestic oil prices towards international levels; and moving domestic prices for natural gas to an appropriate competitive relationship with oil over the next 2-4 years;
- reducing the average rate of growth of energy use in Canada, over the next ten years, to less than 3.5% per year;
- reducing our net dependence on imported oil in 1985 to one third of our total demands;
- maintaining our self-reliance in natural gas until such time as northern resources can be brought to market under acceptable conditions; and
- doubling, at a minimum, exploration and development activity in the frontier regions of Canada over the next three years, under acceptable social and environmental conditions.

Section II
CANADIAN ENERGY POLICIES –THE PAST TWO YEARS

Chapter 1. INTRODUCTION

Through the decade from 1963-1973 the experience in Canada, as in most of the world, was characterized by rapid increases in the use of energy. Total Canadian primary* energy consumption increased by about 5.5% per year during that period. Spurred by the development of low-cost petroleum supplies in the Middle East, and aided by Canadian government policies that provided market protection and substantial incentives to the domestic petroleum industry, the consumption of oil in Canada increased over the same period at about the same average rate as total energy, from almost one million barrels/day in 1963 to about 1.7 million barrels/day in 1973. In 1973, petroleum products accounted for about 47% of Canadian energy use.

Over the same period, annual growth in oil consumption in the United States was 4.7%, in Western Europe 9.4%, in Japan 15.6%, and for the world as a whole, 7.7%. World consumption of oil grew from 26.9 million barrels/day in 1963 (35% of total energy consumption) to 56.4 million barrels/day in 1973 (45% of total energy consumption).

The rapid increases in energy use generally, and petroleum in particular, were driven by favourable conditions of supply—including the ready availability and low cost of production of reserves in the Middle East. During the early 1960's the price of Arabian light crude oil (f.o.b.) was in the neighbourhood of $1.25/bbl. In 1970 it was $1.20/bbl and by September of 1973 it had increased to $2.20/bbl. The low price and ready availability of international oil production constrained the degree to which the prices of other energy forms could increase in a competitive market, and energy prices, relative to the prices of other goods and services, declined continuously through the decade of the 1960's. In Canada, for example, the average cost of energy to individual consumers decreased by about 20% relative to the Consumer Price Index (CPI) between 1961 and 1970. For commercial and institutional users, energy costs declined by about 10% relative to the CPI over the same period, and the cost of energy to Canadian manufacturing companies declined by 8% relative to the CPI and by 30% relative to wage rates.

By 1973, in response to a decade of uninterrupted economic growth and continuously declining real oil prices, the degree of dependence of the industrialized countries on OPEC supplies was so great that the OPEC cartel, in the aftermath of the October 1973 Middle East War, was able to implement the control over the international oil market it had been attempting to exercise since

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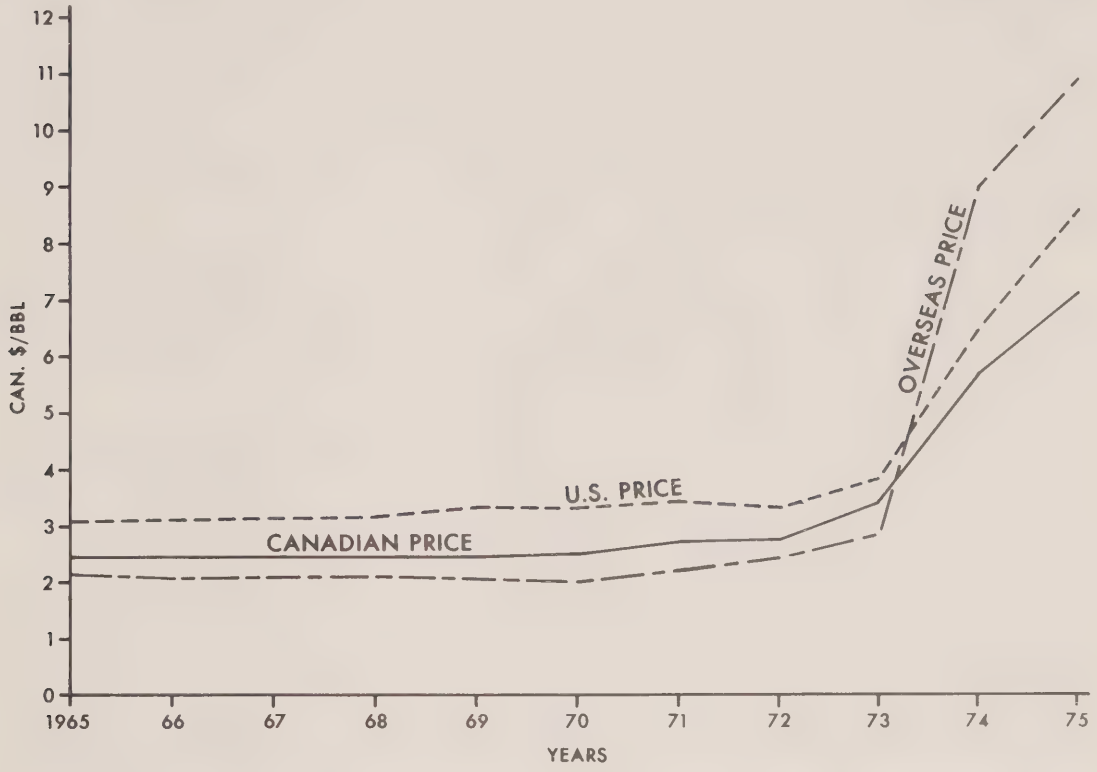
* *Primary energy* refers to the amount of energy made available to the final consumer (secondary energy) *plus* conversion losses and energy used by the energy supply industries themselves (for example, pipelines). *Conversion losses* refer to losses in processing of refined petroleum products, for example, or the losses due to thermal and mechanical inefficiencies resulting from the conversion of fossil fuels (coal, oil or natural gas) into electricity in thermal power generation plants. Unless specifically noted, *total energy* in this publication refers to total primary energy.

the early 1960's. The evolution of Canadian, U.S. and international oil prices over the past decade is shown in Figure 1.

Figure 1. Price at source of Canadian, United States and overseas crude oils, 1965-1975



NOTE: The Canadian price is the average value at the wellhead for domestically produced oil. The average price for overseas oil is the average f.o.b. port-of-loading price for all crude oils imported to Canada (Source: Statistics Canada, *Trade of Canada*). The U.S. price is taken from American Petroleum Institute's *Basic Petroleum Data Book*, 1975, Section VI, Table 1, and adjusted for exchange rate differences.

As a result of the huge OPEC price increases of late 1973 and early 1974, the oil-export revenues of the OPEC countries escalated from less than $30 billion (U.S.) in 1973 to about $110 billion in 1974. Imports of goods and services by OPEC from the rest of the world also increased dramatically through 1974, but the current account surplus of oil exporters, as estimated by the OECD*, was still about $67 billion, compared with a current account surplus of less than $4 billion in 1973. The counterpart of this OPEC surplus was a deficit of about $33 billion for the OECD countries (compared to a $2.5 billion surplus in 1973) and a deficit on current account of about $17.5 billion for the non-OPEC developing countries (compared to a deficit of $5 billion in 1973).

The capacity of oil-importing countries to absorb the higher prices for oil depends ultimately on the health and vitality of their domestic economies. The

* *OECD Economic-Outlook*, July 1975, p. 59.

oil price increases themselves made the difficulties of adjustment more severe by compounding rates of inflation that were already abnormally high and by reinforcing a cyclical downturn in real economic activity. The result has been the most serious recession in the industrialized world since the 1930's coupled with, and to some extent reinforced by, continuing rapid inflation. The total Gross National Product in the OECD countries increased by 6.3% in 1973, while in 1974 output declined by 0.1%. Preliminary estimates indicate a real decline of 1.5% in 1975*. The recession has been particularly severe in the United States with real GNP decreasing by 2.1% in 1974 and an estimated 3.8% in 1975. At the same time consumer prices in the OECD countries which, prior to the oil price increases, had been estimated to rise by about 7% in 1974, actually increased by 13.4% in that year.

It is impossible to disentangle in a precise manner the effects of the OPEC actions on world economic performance in 1974 and 1975. But there is no question that the fivefold increase in the price of oil has been a major factor in the poor economic performance of the past two years.

The effects of the massive price increases for oil and uncertainties of supply have led to a number of reactions by the major industrial nations, both collectively and individually. Balance-of-payments problems, continued high rates of inflation coupled with recession and high levels of unemployment, and the very serious implications of these factors for many developing countries—especially the poorest, whose development planning was seriously disrupted—posed immediate threats to the stability of the international economic system and emphasized the increasing interdependence of all nations in a global economy. Over the past two years there has been tangible evidence of a real desire on the part of all countries to work together to improve the international economic system. New and innovative ideas have been proposed, discussed and acted upon; new international forums have been created to deal with the changed energy and economic situations. Canada has played an important role in this process of multilateral cooperation, while also increasing bilateral contacts to the same end.

At the same time, the Government of Canada has taken a number of domestic initiatives to facilitate the adjustment process that Canadians will have to face in moving from an era of cheap and abundant energy to a more costly energy system. The remainder of this Section reviews the international developments in which Canada has participated and the energy policy decisions taken by the Government of Canada over the past two years**.

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* *Ibid.*, p. 13.

** A chronological listing of the major energy policy decisions by the Government of Canada is presented in Annex I.

Chapter 2. INTERNATIONAL DEVELOPMENTS

In the spring of 1974, the immediate problems facing the world economic community were to facilitate the adjustments necessary to finance the balance-of-payments deficits of oil-importing countries, and to take concerted action to protect against the eventuality of possible future reductions in international oil supplies.

It appeared that the most critical aspect of the balance-of-payments problem in the short term would be the "recycling" of the OPEC financial surpluses. On an aggregate basis, oil-importing countries receive from oil-exporting countries, either in payment for goods and services that OPEC buys from them, or as inflows of capital, sufficient foreign exchange to finance their oil imports. While revenues match expenditures for all countries taken together, individual countries may still experience balance-of-payments problems because the distribution of "petrodollars" among oil-importing countries does not correspond to the distribution of oil imports.

Two major initiatives have been undertaken to alleviate these problems. In 1974 the International Monetary Fund (IMF) established the IMF oil facility, a special fund of almost $4 billion. This amount was borrowed mainly from the oil-exporting countries and loaned to importing countries, mostly in the developing world, for an average term of five years and in amounts related to the increase in their oil-import bills. In 1975 the facility was renewed for more than $6 billion and an important addition was made in the form of provision for an interest subsidy on loans made to the most seriously affected oil-importing developing countries. The second major initiative was the agreement in 1975 by the countries in the OECD to establish a "safety net" for industrialized countries. This "safety net" takes the form of a mutual aid fund, in the amount of $25 billion, whereby credit or credit guarantees can be provided as a last resort to the financially weaker members of the organization. These two innovative concepts, together with substantial aid transfers by both the industrialized countries and the oil exporters and a greater than anticipated demand for imports on the part of OPEC, have substantially eased the recycling problems that were anticipated over the past two years.

The second immediate problem, that of providing mutual protection against the possibility of future embargoes, was dealt with by the establishment, within the OECD framework, of the International Energy Agency (IEA). The IEA is an organization of eighteen industrialized countries*. Its basic objective is, through multilateral cooperation, to reduce the vulnerability of participating

* Countries belonging to the IEA are Austria, Belgium, Canada, Denmark, the Federal Republic of Germany, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, Turkey, the United Kingdom, and the United States.

countries to changes in the price and availability of imported oil. It is hoped that by so doing, the IEA will contribute to the development of a stable world energy order that will take due account of the concerns of producing countries and consuming countries, both industrialized and developing.

To aid in meeting this objective the countries participating in the IEA agreed to an emergency sharing plan in 1974. This plan, which is described in more detail in Section IV, provides for the equitable allocation of international oil supplies in the event of future curtailments. As well, member countries have recently adopted a program of long-term cooperation directed at reducing the dependence of the group on imported oil and promoting stability and equity in the international oil market. Canada was one of the countries originally involved in the formation of the Agency and has participated actively in the elaboration of the emergency sharing plan and the program of long-term co-operation.

The long-term program involves international cooperation in the areas of energy conservation, the accelerated development of alternative energy sources, and research and development. In addition, it contains provision for a minimum safeguard price for international oil of $7.00 per barrel. All countries participating have agreed that, should the world price of oil fall below the minimum safeguard price, imported oil would continue to be sold at or above the minimum safeguard price in their domestic economies. The general intent of this provision is to safeguard investments within an importing country in alternative energy sources. For countries like Canada, with potential energy sources that are expected to be high in cost, it eliminates some of the risk that a drastic decline in international oil prices would render alternative projects non-competitive.

On a broader scale, a new and innovative approach to international cooperation was successfully launched at the Conference on International Economic Co-operation in December 1975. Ministers representing twenty-seven participants, eight industrialized and nineteen developing countries (including seven OPEC members), agreed to establish four commissions to examine problems related to energy, raw materials (including food), development, and finance. These commissions, which are restricted to fifteen members each, are to report to Ministers at the end of 1976. Canada, as one of the two co-chairmen of the Conference, played an important part in the success of the December meeting and will have a continuing coordinating role in the work of the Conference. In addition, Canadian representatives will participate directly in the work of the two commissions dealing with energy and development. It is hoped that discussions among producers and consumers of oil, within the framework of the Conference, will contribute to stability of the international oil market.

Canada is also seeking, through bilateral channels, to promote stability in international energy trade. In this respect, the visits early in 1976 of the Prime Minister to Venezuela and of the Secretary of State for External Affairs to the Middle East have contributed to better mutual understanding between the governments of Canada and of some of the major oil-exporting countries.

The perspective with which Canada approaches both the International Energy Agency and the broader dialogue now taking place internationally between consumers and producers of oil is unique. Although Canada is a substantial producer of oil and exports oil to the United States, the country as a whole is now a net importer of crude oil and our dependence on foreign sources of supply will continue to increase for some time. In addition, within Canada some provinces are substantial net exporters of oil while others are net importers. Finally, the Canadian energy system, like the world energy system, has finite proved reserves of oil and natural gas which are declining relative to the growth in demand. While potentially large additions to oil and natural gas reserves are thought to exist in Canada, new supplies are unlikely to become available except at much higher real costs.

Among nations (as within the Canadian confederation), the fundamental issue that has been raised by the OPEC oil price increases is the question of the most orderly way of facilitating a global redistribution of income and wealth. Expressed alternatively, how does one determine an "appropriate" price for oil, taking account of the need to guarantee the adequacy of future supplies, the legitimate desire of producing governments to receive a reasonable return on a finite and depleting asset, and the need to make the transition from low-cost to high-cost energy sources as easy as possible for consumers? Striking an acceptable balance will not be easy, but in many respects these problems are similar to the nature of the problems we face within Canada. The process we have begun in Canada, a process of negotiation among consuming and producing provinces, is a positive and constructive approach. A similar process is now underway internationally in the Conference on International Economic Co-operation.

An oil tanker unloading at Point Tupper, Nova Scotia.

Chapter 3. CANADA-UNITED STATES ENERGY RELATIONS

Energy questions are an important element of bilateral relations between Canada and the United States. The United States has been the traditional market for Canadian exports of oil and natural gas, and for many years Canada has imported coal from the United States to supply more than half of total Canadian requirements. In addition, trade in electrical energy has been growing in importance. This energy trade is of significance to both countries, and a consultative process has evolved to minimize any disruptive effects that might occur because of national energy decisions taken in either country.

Since 1959 the United States has not permitted international oil prices to rule in its market and has maintained various restrictive measures with respect to imports. It has also maintained control over the prices at which domestic oil production is sold. Despite the present administration's declared policy to move towards international prices for domestically produced energy, President Ford in late December signed into law the omnibus energy bill sent to him by Congress. This law resulted in the removal of a $2 per barrel supplemental fee on imported crude oil and, effective February 1, 1976, lowered domestic crude oil prices with the result that the average cost of domestically produced and imported oil is about $10.00 per barrel. The prices of natural gas sold in interstate trade are also controlled, interstate pipeline purchases averaging approximately 45 cents per thousand cubic feet (Mcf) in September 1975. In some intra-state transactions, where the price of natural gas is not controlled, prices have recently exceeded $2 per Mcf. Partly because of price controls on natural gas, the U.S. has faced shortfalls in supply for some years now and available supplies have had to be allocated.

U.S. oil import quotas continued in effect through the 1960's, although they were gradually relaxed to permit rising imports as domestic consumption increased and domestic production declined after 1970. Since 1973, when quotas were removed, imports have accounted for about one third of U.S. oil consumption. Canadian exports have been a relatively small proportion (about 17% in 1973) of total U.S. imports, but they were and continue to be a necessary source for certain refineries in some northern states. In March of 1973, the Government of Canada, concerned that the rapid increase in Canadian exports to the United States would lead to domestic supply problems, instituted a program to control oil exports. In October of 1974 the National Energy Board reported that Canadian oil supplies would be inadequate to serve traditional Canadian markets as well as part of the Montreal area beyond 1982 and recommended that exports be phased out. The export level was therefore reduced as of January 1975 to 800,000 barrels a day, and exports during 1975 averaged about 700,000 barrels daily (compared to a level of 1.2 million barrels a day in 1973). As a result of a further report by the National Energy Board dated September 1975, allowable exports for 1976 have been set at an average level of 460,000 barrels a day.

As our exports continue to decline, the proportion of our production of heavy oils available for export will rise. Canadian refineries are not currently equipped to accept large amounts of heavy oil and it will be necessary to continue to pursue measures that will ensure that appropriate markets exist for such oil.

No new licences for the export of Canadian natural gas have been granted since 1970. Natural gas exports in 1974 accounted for approximately 40% of total Canadian production of marketable gas, although these exports represented only 4.5% of U.S. gas supply. The National Energy Board, in April 1975, warned that Canadian natural gas supply could fall short of meeting total demand including existing export commitments in the latter part of the 1970's. Amendments to the National Energy Board Act will be introduced to facilitate the allocation of natural gas supplies among consuming provinces in the event of shortages. Clearly exports would have to be reduced under such conditions and the federal government will be pursuing consultations with U.S. officials and Canadian provinces to determine the manner in which such shortages, should they occur, could be shared in an equitable manner.

Industrial users in central Canada, particularly the Ontario steel companies, have traditionally imported coal from the United States. OPEC action on oil pricing affected these imports, coinciding with a period of strong international demand for steel and an under-supply of coking coal. During 1974, increased utilization of coal within the United States and other factors such as strikes by coal miners resulted in uncertainties with regard to coal supply from the United States to Ontario.

Trade in electricity has been on a modest scale and varied in recent years from a small net import in 1968 to a net export of 5.6% of net Canadian electricity generation in 1973. The net value of exports reached a maximum of $169 million in 1974. Exports arise from a variety of situations including surplus hydroelectric capacity due to above-average water flows, and economic interchange of thermal generated electricity (often from coal imported from the U.S. or from imported oil). Seasonal diversity exchanges between winter-peaking Canadian utilities and summer-peaking U.S. utilities, together with mutual assistance in emergencies, are of increasing importance. Exports in a few cases permit greater economies in the scale of Canadian generation additions by selling a portion of capacity in advance of domestic demand. With suitable regulation of export price and conditions as provided by National Energy Board regulation, electricity exports are mutually advantageous to both countries but do not represent a long-term commitment of any major significance in determining generation expansion patterns for Canadian needs.

With regard to the pricing of energy exports, the Government of Canada considers that exports of energy products should be sold at world market prices, comparable for example, to the prices of the oil Canada imports. Thus since late 1973, when the international price of crude oil began to increase markedly, an export charge has been levied on Canadian crude oil exports, basically

designed to reflect the difference between the export price found by the National Energy Board to be "just and reasonable" and the price of crude oil produced for domestic consumption. Export prices for natural gas are determined in relation to the prices of competitive energy commodities in the market in which the gas will be sold. Since November of 1975, the export price has been $1.60 per Mcf.

Early in 1976 negotiations were concluded between Canada and the United States for a bilateral treaty relating to oil and gas pipelines crossing the territory of one country to deliver oil or gas to the other, either from another part of its own territory (for example, the Interprovincial-Lakehead pipeline system from Edmonton to Sarnia) or from overseas (for example the Portland-Montreal line). The treaty would guarantee non-interference with such shipments and non-discrimination in related transportation charges.

A further mutually beneficial approach, to which both governments have agreed in principle, is the possibility of a "swapping" arrangement of Canadian oil in return for United States domestically produced oil. Such arrangements for oil, and possibly for other energy commodities as well, could lead to the efficient use of existing transportation, refining and distribution facilities, while protecting the security requirements of both countries. Companies have been invited to consider suitable commercial arrangements and to submit viable proposals.

In general, while the Government of Canada has rejected the concept of a continental energy policy, constructive discussions with the Government of the United States, directed at determining those areas where cooperation is to the advantage of both countries, are and will continue to be a feature of our bilateral energy relations.

Passenger cars are one of the biggest consumers of oil products—(Ontario Ministry of Transportation and Communication photo).

Chapter 4. DOMESTIC POLICY INITIATIVES

When the world was faced with higher oil prices and supply cuts in the winter of 1973-74, Canada was one of the few industrialized countries that was, on balance, self-sufficient in oil. In 1973 Canadians used about 1.7 million barrels/day of petroleum products. Canadian crude oil production averaged about 2.1 million barrels/day. While almost 1.4 million barrels/day of crude oil and products were exported to the United States, approximately one million barrels/day were imported, primarily from Venezuela and the Middle East.

The National Oil Policy, introduced in 1961, divided Canada into two consuming regions. The area west of the "Ottawa Valley Line" was reserved for domestic oil production while the area east of the Line was served by imported oil. During the decade of the 1960's Canadian oil production was constrained by the size of the Canadian market west of the Ottawa Valley Line and the existence of import quotas imposed by the Government of the United States. Attempts to expand the Canadian pipeline system to serve the area east of the Ottawa Valley Line with indigenous oil were resisted by the eastern provinces, which enjoyed the benefits of lower-priced foreign oil. Indeed, one of the characteristics of the National Oil Policy was the maintenance of a two-price system for oil in Canada. Prices in the market reserved for Canadian production were higher than prices paid by consumers in the eastern part of Ontario, in Quebec and in the Atlantic Provinces.

After U.S. oil production peaked in 1970, American imports rose rapidly and the quotas were removed in April of 1973. From 1970 to 1973 Canadian oil exports increased by about 83% and the Government of Canada, concerned that the rapid growth in export demands might deprive Canadian refineries of their crude oil supplies, began to control crude oil exports in March of 1973. The rapid growth of U.S. demand for imported oil in the period 1970-1973 contributed to upward pressure on international oil prices. Canadian crude oil prices moved upward as well, and were $3.80 per barrel at the wellhead in August of 1973. In September of 1973 Canadian crude oil prices were frozen at this level and a special charge was levied on exports of Canadian oil to the United States. In retrospect, it is interesting to note that what have become major elements in the management of the Canadian oil system—control over domestic prices, control over export volumes, and the export charge—were all in place by September of 1973, one month before the outbreak of war in the Middle East and the ensuing oil embargo.

In the aftermath of the oil embargo and the OPEC price increases, the immediate adjustment problems facing Canada were quite different from those facing most oil-importing countries. Because Canada was at the time self-sufficient in oil production, and indeed a net exporter, the immediate problem was not to ease the transfer of real and financial resources to oil-exporting

countries, but rather to facilitate the transfer of income and wealth within the country, from oil-consuming provinces to oil-producing provinces, in such a way that the legitimate aspirations of the oil-producing provinces could be realized while minimizing the disruption to the broader social and economic well-being of all Canadians.

The policy actions of the Government of Canada over the past two years have been taken to protect Canadians from the economic distortions visited on the rest of the world by the rapid increase in oil prices while, at the same time, in the light of declining proved oil reserves in Canada, to maintain and enhance the opportunities for Canadian self-reliance in energy. These principles have been given expression in a number of government policies and programs. The transition from low-cost to higher-cost energy has been eased by federal-provincial agreement on new pricing policies for Canadian oil and natural gas, and a number of initiatives directed at increasing the degree of our self-reliance in energy have been undertaken. These are elaborated below.

Easing the Problems of Adjustment: Oil and Natural Gas Pricing

In January of 1974, with international oil prices at $9.60/bbl (f.o.b.) and domestic oil prices frozen at $3.80/bbl, Canadian First Ministers met to discuss future Canadian oil pricing policy. The Government of Canada had allowed importers of oil to pass through some of the increase in the cost of foreign crude oil to their customers in eastern Canada, with the result that traditional Canadian pricing relationships had become reversed. Oil products in the regions of the country served by imports had become more expensive than similar products produced from domestically supplied crude oil.

In this context the Government of Canada proposed that there should be a "single-price oil policy" in Canada, under which Canadians across the country would pay the same price for crude oil, subject only to transportation and quality differences. This policy was accepted by the provincial governments and it was agreed to extend the price freeze and export charge until the end of March, 1974.

In late March, First Ministers agreed that the crude oil price would increase from $3.80/bbl at the wellhead to $6.50/bbl on April 1 and remain at that level for fifteen months. It was further accepted that revenues from the export charge would be used to finance payments to oil importers so that they could sell imported oil to eastern Canadian consumers at prices consistent with an Alberta wellhead price of $6.50 per barrel.

It is important to recognize the logic of the single-price oil policy. It effectively allowed Canadians to price oil substantially below world prices and to manage that system in such a way that, as long as we remained self-sufficient in oil, there would be no net transfer of income and wealth from Canada to oil-

exporting countries. Increases in the price of our oil imports would be offset by increases in the price of our oil exports.

Through the combination of the export charge and the oil import compensation program it was possible for consumers across Canada to purchase petroleum products at prices consistent with the price of domestic crude oil. At the same time, however, it was recognized that the single-price oil system could continue to operate in this way only so long as we remained self-sufficient. It was further recognized that, in view of the desires of producing provinces to secure larger financial returns from a depleting asset, the high and rapidly increasing cost of additional sources of supply, and the necessity to encourage efficient and prudent use of a non-renewable resource, oil prices in Canada would have to move closer to world levels. However, the extent to which they would have to rise would be determined by the costs of additional Canadian energy resources, and not necessarily by actions of the oil-exporting countries. Similarly, the rate at which they increased could be phased in with some flexibility in order to allow Canadian consumers time to adjust to more expensive energy. Finally, it should be recalled that the decision to move to an oil price of $6.50 per barrel was taken in a climate of substantial uncertainty: it was not clear to what degree OPEC would be able to maintain the extremely high price it had set for international oil; nor were the future supply prospects and costs from Canada's frontier areas and the Athabasca oil sands very clearly delineated. It was felt that the 1974 pricing agreement would provide a useful period in which the future prospects for international oil prices and domestic supply and demand conditions could be more accurately assessed.

The 1974 oil-price agreement provided advantages to Canada. During 1974, the price of oil to Canadian consumers averaged about $5.80 per barrel, about $4 to $5 per barrel lower than the international price. In part because of our lower oil prices, total production of goods and services in Canada increased by 2.8% in 1974, compared with real declines in the OECD countries, as a group, of 0.1% and in the United States of 2.1%. Similarly, the Canadian unemployment rate averaged 5.4% in 1974, lower than the 5.6% recorded in 1973. The U.S. unemployment rate, over the same period increased from 4.9% to 5.6%. The Canadian rate of inflation increased from 7.5% in 1973 to 10.9% in 1974, but this increase of about 3.4 percentage points compared favourably with increases of about 4.8 percentage points in the United States and 5.5 for the OECD countries as a group.

Although Canadian economic performance in 1974 was relatively good in comparison with that of our trading partners, it was not possible for Canada, as a major trading nation, to escape the effects of an international recession that proved much deeper and more protracted than was anticipated. By April 1975, when First Ministers met again to consider a new oil-pricing agreement, it was clear that the Canadian economy was experiencing a downturn. There had been virtually no real growth in the final quarter of 1974. The unemployment rate, although still below the United States unemployment rate of 8.7%, had increased from 6.0% in December of 1974 to 7.2% in March of 1975. The

annual rate of increase in consumer prices, although it had been declining for four months, was still in excess of 11%.

In this context there was strong opposition at the April 1975 First Ministers' Conference, particularly from some of the oil-consuming provinces, to any further increase in the wellhead price of Canadian crude oil. However, information that had become available during the previous twelve months, and which was presented to the Conference and to the public by the Government of Canada*, suggested that there were strong and compelling arguments in favour of continuing the phased increase in domestic prices towards international levels.

During the period for which the Canadian price had been fixed at $6.50 per barrel at the wellhead (or about $7.20 per barrel in Toronto), prices of international oil delivered to eastern Canada had continued to increase, from about $10.50 per barrel to a little over $12.00 per barrel. The average U.S. price had increased to about $9.75 per barrel. At the same time it had become apparent that Canadian indigenous oil supplies were declining and further additions to those supplies would be very costly to find, produce and bring to market. For example, the experience with the Syncrude oil sands project in the months preceding the April Conference had established that further production of synthetic oil from the Athabasca oil sands would be economically practicable only at prices much higher than $6.50 per barrel. Indeed, despite the existence of special fiscal incentives for the Syncrude project, it would appear necessary to sell the output at prices at least equal to current international levels to ensure the profitability of the operation.

In addition the National Energy Board had reported, in October of 1974, that Canadian oil supply would not be adequate to serve the traditional Canadian market (that area west of the Ottawa Valley Line) as well as part of the Montreal market beyond 1982. The Board recommended that exports to the United States be gradually phased out and the federal government responded by reducing authorized export levels as of January 1975. Continued growth in imports, together with export reductions resulted in the fact that, by early 1975, Canada was no longer statistically self-sufficient in crude oil: exports from western Canada were less than imports to eastern Canada. The loss of Canadian self-sufficiency meant that it was no longer possible to avoid the net transfer of income and wealth from Canadians to oil-exporting countries. Revenues from the export charge would no longer be adequate to cover the compensation bill for imported oil. The continued subsidization of a lower Canadian oil price would require increasing contributions by Canadian taxpayers.

Downward revisions in the estimates of Canadian oil supplies, increases in the expected costs of new supplies, and the continued advance of international oil prices had convinced the Government of Canada that it was in the national

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* *Background Paper on the Canadian Energy Situation*, prepared by the Government of Canada for the Conference of First Ministers, April 9-10, 1975.

interest to increase the domestic oil price. In his opening statement to the First Ministers' Conference of April 1975 the Prime Minister remarked:

We cannot expect those who search for oil—whether they be Canadians or others—to look for it and develop it in Canada if our prices are far below other countries. We cannot go on year after year being extravagant in our use of oil far beyond what almost every other country in the world consumes—mainly because it is being sold cheaply in Canada, a lot cheaper than elsewhere and a lot cheaper than our future supplies will cost. We cannot expect Alberta and Saskatchewan to go on year after year selling their oil to Canadians at a price which is far below what they could get by exporting it.

So my colleagues in the government and I have come reluctantly to believe that the price of oil in Canada must go up—up towards the world price. It need not go all the way up. We should watch what happens to the world price and decide from year to year what we should do.

In the economic and political climate of April 1975, it proved difficult to strike an appropriate balance between the adverse short-term impacts of higher prices and the necessity to protect the medium-term interests of Canadians. Attempts to reach agreement were complicated further by actions that had been taken by the governments of the producing provinces and the federal government with regard to an appropriate fiscal system for the Canadian petroleum industry*. In the event, it was impossible to reach a consensus at the April conference or in the following months. Therefore, under the terms of the Petroleum Administration Act, and through an understanding reached with the governments of the producing provinces, the Government of Canada announced in a budget statement on June 23, 1975 that wellhead prices for domestic crude oil would increase to $8.00 per barrel on July 1, 1975 and remain at that level for twelve months. In addition, in order to relieve the general taxpayer of the burden of subsidizing Canadian consumers of oil a special excise tax of ten cents per gallon was applied to sales of motor gasoline for non-commercial use. The proceeds of this tax are being used to make up the growing deficit between the oil import compensation payments and the dwindling revenues from the oil export charge.

It was further announced, in the June budget, that the price of natural gas at the Toronto city-gate would increase to $1.25 per thousand cubic feet (Mcf), effective November 1, 1975. In early 1974 the field price of natural gas in Alberta averaged about 22¢ per Mcf which, allowing for transportation, resulted in a Toronto city-gate price of 62¢ per Mcf. As the energy contained in one barrel of crude oil is roughly equivalent to the energy contained in six Mcf of natural gas, it was apparent that natural gas was substantially undervalued relative to crude oil. Considering the "clean-burning" characteristics of natural gas, this undervaluation was even more marked relative to the petroleum products natural gas competed with in particular markets. Partly as a result of this relatively favourable pricing structure the domestic demand for natural gas had more than tripled in the ten years from 1962 to 1972. Consumption had been growing at

* The modifications to Canadian fiscal systems in 1974 and 1975 and their impact on the petroleum industry in Canada are discussed in Chapter 5.

just under 12% per year and the share of natural gas in total Canadian energy consumption had doubled. Until 1970 new discoveries had more than matched annual production rates, so that proved reserves in the established areas continued to increase from about 35 trillion cubic feet (Tcf) in 1962 to about 57 Tcf in 1970. At the end of 1974, remaining proved reserves in these areas were estimated at about 57 Tcf.

The continued underpricing of natural gas, particularly in the face of pending increases in crude oil prices, would have accelerated the increase in demand and further lessened the incentive to develop potential but yet unproved gas reserves in the western provinces as well as in the frontier areas of Canada. The Government of Alberta had, for a period of two years, refused to permit new contracts for domestic sales outside of Alberta. In January of 1974 the Alberta Arbitration Act was amended so that energy-equivalent values for natural gas would serve as the major criterion in setting field prices. As a result of a subsequent arbitration decision*, the price of natural gas in Toronto rose, effective November of 1974, to about 66% of this "commodity equivalent" price.

Although natural gas pricing was not explicitly discussed at the January 1974 Conference of First Ministers, the Government of Canada did express its concerns, both at the undervaluation of natural gas and at the prospect of Alberta arbitration procedures removing this undervaluation in a time frame that would be so short as to cause serious adjustment problems for Canadian consumers of natural gas. Consistent with the principles it had put forward with regard to the phased adjustment of crude oil prices, the federal government recommended that domestic natural gas prices be gradually phased to commodity-equivalent value with crude oil delivered to the major consuming market. Possible phasing alternatives were discussed with producing and consuming provinces through the fall of 1974 and spring of 1975. In April of 1975 the matter was raised at the First Ministers' Conference but no consensus was reached. Between the time of the conference and the June budget announcement, an arbitration decision was announced in the Province of Alberta which would have increased the field price of natural gas to $1.15/Mcf on November 1, 1975. This would have meant a city-gate price in Toronto of $1.60-$1.65 per Mcf.

In June the Government of Canada announced that, as part of the understanding it had reached with Alberta, the city-gate price of natural gas would rise to only $1.25/Mcf in Toronto on November 1, 1975. This price represents about 85% of the commodity-equivalent value of delivered crude oil, and the federal government announced its intention to see the remaining gap of 15% eliminated over a period of three to five years.

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* This decision led to the establishment of a field price of 60¢/Mcf as of November 1, 1974. The effect of this was to raise the average field price of Alberta gas flowing eastwards through the TransCanada system to about 45¢/Mcf in November, 1974. The city-gate price at Toronto, the major consuming market, rose to about 82¢/Mcf at the same time. At that time, crude oil was selling for $6.50 per barrel at the wellhead and about $7.20 per barrel delivered to Toronto. The Toronto price for natural gas that would have been equivalent to crude oil, on a delivered cost of energy basis, was about $1.24/Mcf.

The federal government has also stated, on a number of occasions, its objective of phasing the export price of natural gas to commodity value with competitive fuels in the markets to which it was being delivered. Effective January 1, 1975, the border price of Canadian natural gas exports increased to $1.00/Mcf and it was further increased to $1.40/Mcf in August, 1975 and $1.60/Mcf in November of 1975. The effect of these domestic and export pricing decisions has been to increase the average field price for natural gas in Alberta to about 95¢ per Mcf. These higher prices have provided an important stimulus for further exploration and development in both the western provinces and in Canada's frontier areas and, as well, a necessary source of funds to carry out these more costly exploration and development programs. In addition, the movement to higher prices was instrumental in securing the agreement of the Government of Alberta to release an additional 1.4 Tcf of natural gas reserves, for delivery to consumers in Manitoba and Ontario. These additional reserves will help to ease a potential shortfall in the supply of natural gas to these provinces.

The position of the Government of Canada with regard to oil and natural gas pricing has been based consistently on three principles:

- the commitment to a single-price policy for crude oil in Canada, subject to transportation differences;
- the commitment to remove the undervaluation of natural gas in both domestic and export markets; and
- the intention to use our resources to phase in price increases for oil and gas in a manner that affords an opportunity for Canadian consumers to adjust to higher prices.

In the process of translating these principles into specific policies, it is necessary to consider the overall economic prospects for Canada in the short term, as well as the respective positions of both producing and consuming provinces. In addition, decisions must adequately reflect the continuously evolving energy situation, both in Canada and abroad. We have the ability to manage the transition to higher-cost energy systems in an orderly fashion because we have domestic oil reserves which can cushion us from the shocks similar to those that have been imposed on other countries. However, this ability is diminishing as these reserves are depleting. Our prospective energy situation for the next fifteen years is assessed, and some of the implications of that assessment presented, in Section III. These implications indicate that further price increases for domestic crude oil and natural gas are required. What is necessary in deciding these further increases is to determine an appropriate balance between the short-term costs and the longer-run benefits to Canadians. The Government of Canada remains committed to a process of discussion, of negotiation, and to consensus if possible. But if it becomes clear that consensus cannot be achieved, as it could not in April of 1975, then the federal government will be compelled to take those decisions which must be made in the national interest.

Increasing Self-Reliance

The successful manipulation of the price and supply of as vital a commodity as oil, and the possibility that a few countries that are large international producers may be in a position to manipulate the market in the future, for political as well as economic purposes, have led to concern on the part of the federal government with regard to future self-reliance in energy. This concern is similar to that of other oil-importing countries, although in the case of Canada the appropriate policy choices are more complex because of our potentially large, but very costly, energy resources.

In 1973, Canada was a net exporter of oil even though about half of total Canadian requirements was provided by imports. The ability to increase production in western Canada and to organize emergency transportation facilities allowed eastern Canadian consumers to respond to the embargo of 1973-74 with little discernible effect on their oil supplies. Recent reports by the National Energy Board, however, have indicated that our ability to supply fully even our traditional consuming markets plus part of the Montreal market with indigenous oil will disappear in the early 1980's, unless new sources of supply are developed. In response to these reports the federal government has reduced allowable oil exports in order to extend the period during which Canadian oil supplies can continue to serve the Canadian market. One result of decreasing allowable exports was that Canada became a net importer of crude oil in 1975 as total consumption rose above total production for the first time since 1969. The Board's most recent forecast, in September of 1975, suggests that, barring major technological advances in the oil sands or large new discoveries, Canadian dependence on imported oil will continue to increase. The Board estimated that *net* imports to Canada might amount to 45-50% of total Canadian requirements by 1985.

The Government of Canada has taken a number of energy policy initiatives, on its own and in concert with the provinces, which are directed at reducing the risks—both economic and non-economic—associated with increased dependence on imported oil. Such policies have been aimed, in the first instance, at minimizing such risks by reducing the degree of future Canadian dependence on imported oil. They have also focussed on increasing our emergency preparedness in the light of possible future curtailments in international oil supplies. They have included:

- new measures to ensure the efficient use and conservation of all energy sources, and oil in particular;
- new export policies for uranium and oil, designed to increase the degree of protection for future Canadian requirements;
- expanded resource assessment programs, in cooperation with provincial governments, particularly for coal and uranium;
- increased federal financial support for interregional electrical interconnections, to facilitate the more efficient development and use of electrical power in Canada;

- increased federal financial support for nuclear generation, in particular financial assistance for the construction of the first reactor in a province;
- participation with the Governments of Alberta and Ontario, and with the private sector, in the Syncrude oil sands project;
- the establishment of a Canadian national oil company, Petro-Canada, with an equity and debt funding of $1.5 billion;
- an increased level of funding for Panarctic Oils Limited, in which the federal government has a 45% share;
- financial participation, with the Government of Ontario, in the Polar Gas project;
- the establishment of priorities for energy research and development and increased federal funding of energy R & D;
- extension of the domestic oil pipeline system to Montreal, with federal financial guarantees and with the potential to deliver imported or eastern Canadian oil to Ontario if necessary;
- the participation, with seventeen other countries, in the emergency sharing scheme of the International Energy Agency;
- the development of an emergency allocation program by the Energy Supplies Allocation Board, to be implemented if international oil supplies are curtailed; and
- participation in the Conference on International Economic Co-operation in which a dialogue has been opened among oil-importing and oil-exporting countries.

Because Canada has favourable geological conditions for the occurrence of energy resources, we have more options available to us than many other countries. However, because information on the extent of the domestic resource base is incomplete, because the costs of finding these resources and converting them to energy supplies are relatively high, and because there remains substantial uncertainty with regard to future international oil prices, choices are difficult.

Capital costs of all major construction projects have escalated rapidly in recent years. For example, in 1973, it was estimated that a limited number of open-pit mining projects in the Athabasca oil sands would be economically attractive at prices between $3.75 and $4.00 per barrel. It was further suggested that about 35 billion barrels could be recovered for a price, in 1972 dollars, of about $6.00 per barrel. Subsequent technological and environmental problems, together with substantially increased capital and labour costs, have raised the estimated cost of the Syncrude project from $800 million to over $2 billion. It now appears that, barring major technological advances, further oil sands developments may be questionable even at current international crude oil price levels (about $13.00 per barrel landed in Montreal). Drilling experience in

Canada's frontier areas over the past three years has been disappointing with regard to oil. As a result, estimates of ultimate potential resources of oil and natural gas have been reduced sharply. These reductions in the estimates of potential resource availability have led to reductions in the estimates of average field sizes and well productivities resulting in a corresponding increase in the estimated unit costs of developing frontier resources that may be discovered. Estimates of energy-related investment programs over the next fifteen years are presented, and their implications for economic performance are discussed, in Section III.

This combination of disappointing exploration results and rapidly increasing real costs, attributable in part to the worldwide inflationary experience of the past few years and directly to the rapid rise in international oil prices, has led to the realization that, although Canada is relatively well-endowed with indigenous energy resources, their development will be costly and the prices at which they can be economically delivered to consumers will certainly exceed current Canadian prices. In addition, the future development of our potential resource base will demand a much higher component of capital and labour than has traditionally been directed towards the production of energy. This will require, to some degree, the reordering of priorities and the reallocation of Canadian labour and capital towards the production of energy and away from the production of other goods and services. Such a reallocation could lead to difficult structural adjustment problems for certain sectors and regions.

Moreover, the risk exists that determined and successful efforts by Canada and other countries to develop higher-cost resources could shift the global supply/demand balance for OPEC oil to the point where international prices may fall below the costs of additional Canadian energy supplies, leaving Canadian consumers at a competitive disadvantage vis-a-vis importers of OPEC oil. Paradoxically, the greater the degree to which those countries that have high-cost resources develop those resources, the greater the possibility that world supplies will increase to the point where OPEC can no longer sustain its control over international oil prices. Should this occur Canadians could face the prospect of paying relatively more than other consumers for the bulk of their energy supplies. To the extent that positive action is not taken to develop this potential, however, the durability and effectiveness of OPEC will increase. Canadians will be exposed to the risks associated with increased dependence on relatively few foreign suppliers, some of whom have already demonstrated that their control over the international oil market may be exercised for political as well as economic ends.

In this context the policy initiatives taken by the Government of Canada over the past two years have been directed at increasing our capacity for energy self-reliance, while maintaining a degree of balance and flexibility that is essential in the light of the considerations discussed above. Energy problems are complex, interacting in both direct and indirect ways with economic, social, environmental and constitutional considerations. While there are no simple answers, there are a number of clearly defined directions in which it is necessary to move.

These include the need for better information, the need to develop new energy sources in Canada, the need to conserve energy and the need to ensure that Canadian requirements are adequately protected.

The need for *more accurate and timely information* with regard to the extent and costs of the Canadian resource base, and frontier oil and gas resources in particular, is critical. Compilation of a National Coal Inventory in cooperation with the coal-producing provinces is now underway. This inventory is concerned not only with the geological criteria, including quantity and quality, of coal resources but also with mining, environmental and economic criteria. It will provide a sound basis for future policy considerations. The inventory will be subject to continual reappraisal of the economic recoverability and potential areas of application for each type of coal in each geographic region. The objective of the national inventory has not yet been realized but current cooperation from British Columbia, Alberta, Saskatchewan, Nova Scotia and the coal industry is contributing to its achievement. In addition, a joint federal-provincial uranium reconnaissance program, directed at further delineating Canadian uranium resources, has been initiated.

With regard to petroleum and natural gas, new steps have been taken to accelerate the delineation of our frontier resource base through the creation of a national oil company. Petro-Canada will participate actively in frontier exploration. It will be able to mobilize capital on an important scale, even by the standards of those large private enterprises which characterize the Canadian petroleum industry. The initial capitalization of $500 million can be supplemented by debt financing up to $1 billion.

Petro-Canada is not expected to replace private corporations engaged in the search for Canadian oil and gas reserves. Rather it is intended to act as a catalyst and to supplement private sector activity in Canada's frontier areas. Exploration for and development of Canadian frontier resources will require capital on a scale not normally available to most Canadian-owned companies. Petro-Canada can play an important role in facilitating the participation of such companies in the search for new Canadian oil and natural gas supplies. In the process it will increase the overall level of exploration activity, expand the number of companies taking part in such activity, increase Canadian participation in the development of Canadian resources and provide an invaluable source of knowledge and insight into both the operation of the petroleum industry in Canada and the future prospects for Canadian oil and gas reserves.

It is also apparent that increasing Canadian energy self-reliance will require the *development of additional supplies* of indigenous oil, and of other energy sources that can be easily substituted for oil imports. In addition to a strong federal presence in the frontier areas of Canada, federal participation in the Syncrude oil sands project, in cooperation with the Governments of Alberta and Ontario and with the private sector, was an important step in assuring that the realization of the vast potential of the Athabasca oil sands would not

be unduly delayed. The experience gained in the operation of Syncrude will be critical to the efficient development of the billions of barrels of oil that are accessible through open-pit mining techniques.

Attempts to facilitate the substitution of domestic energy sources for imported oil have also been enhanced through the federal policies of financial support for provincial or interregional nuclear generation and for interregional electrical interconnections. Examples of federal action in nuclear generation are to be found in loans for the Pickering (Ontario), Gentilly II (Quebec) and Point Lepreau (New Brunswick) nuclear units. Regional transmission studies have been made, to date, for the Prince Edward Island-Mainland interconnection and for the Labrador-Newfoundland transmission system for the Gull Island hydroelectric development. Project financing for these interconnections has been completed (Prince Edward Island) or is pending (Newfoundland).

Along with measures to develop new supplies a strong and vigorous program directed at the *conservation of all forms of energy*, and oil in particular, is essential. The high costs of providing additional supplies, the opportunities for consumers to offset higher prices by reducing consumption, and increasing concern for the environmental implications attending both the provision and utilization of energy, dictate the need for active programs to increase energy efficiency and lower the rate of growth of energy consumption. Energy conservation provides the most immediate method of relieving our energy problems and constitutes the lowest-cost, lowest-risk policy by which energy self-reliance can be enhanced. The Government of Canada established an Office of Energy Conservation early in 1974. In February of 1975 the Minister of Energy, Mines and Resources announced an energy conservation program, consisting of five parts:

- in-house conservation measures directed specifically at the federal government's own operations;
- consultations with provincial governments, with industry, and with labour groups;
- a public information program to inform Canadians of the need to conserve energy and to provide information on how to use energy more efficiently;
- specific conservation measures; and
- initiatives directed at structural adjustments that may be required in the longer-term as we adjust to new energy systems.

Introducing this program the Minister stated that "these will be permanent policies not contingency plans enacted in a crisis."

With regard to its own operations, the federal government has taken a number of steps to revise its method of constructing and of operating buildings, to change the regulations governing travel and purchases, and to establish conservation as a standard practice among its managers. For example, a directive

has been issued limiting future automobile purchases to compact sizes unless there is a specific and continuing need for a larger vehicle. The greatest energy savings have been made with respect to the many federally owned and operated buildings in Ottawa: in the Energy, Mines and Resources headquarters building, total energy use was cut by 30% in one year and, in the Department of Agriculture headquarters building, by 43%. Design standards for construction of new buildings have also been substantially altered: whereas today's buildings require the energy equivalent of about 100 kilowatt-hours of electricity per square foot per year, no new building is expected to exceed 25 kilowatt-hours per square foot per year—a saving of some 75%. Some federal departments have instituted their own conservation programs. The Department of National Defence, for instance, has effected energy savings of well over 20%, resulting from both improved space-heating efficiencies and modifications in use of its transportation fleet.

Consultation has been pursued with the aim of both explaining the need for conservation and winning the support of various sectors of the community. An important element of this process involves working with provincial governments. Many of the most important measures that can be adopted to effect changes in energy consumption practices rest with the provinces, and an active federal-provincial exchange of information has been established. In addition, a wide variety of contacts have been made with industry and labour organizations.

The public information and education program, which is the most visible part of the federal government's efforts to date, has produced impressive results. The program has involved the use of several media including print, radio, television, movies and direct contact (in classrooms, lectures, etc.). Almost one million copies of a booklet entitled *100 Ways to Save Energy and Money in the Home* were ordered, most by individual request. Prince Edward Island has endeavoured to place a copy in the hands of every household in the province. Over a million copies of a special booklet for high school students, together with its teacher's guide, were distributed. Full-page advertisements were placed in most daily newspapers in Canada. Results from readership surveys and partial questionnaires indicate that a great deal of interest has been generated and that Canadians have implemented many of the actions suggested in the information program, with resulting savings in both fuel consumption and personal expenditures. Moreover, preliminary evidence suggests that the people of Canada are beginning to think seriously about conservation as a major element in their way of life.

Although not a major part of the federal conservation program through 1975, some new energy conservation measures have been introduced. For example, insulation standards in the building code followed by Central Mortgage and Housing Corporation (and used as a model by many other lending institutions) were increased substantially in 1975. In addition certain changes were made in tax laws to increase the incentives to conserve, by reducing the cost of insulation and similar materials and by increasing the purchasing costs of large motor vehicles and of fuel for non-business purposes.

Through its participation in several studies, the federal government has begun to investigate longer-term, structural changes that might be appropriate in order to effect a change to what has been called a "conserver society". These studies are quite preliminary and will require further work and public discussion before any can be treated as serious policy proposals.

Finally, in addition to policies directed at increasing supplies and restraining the growth in demands, the Government has taken a number of initiatives directed at *protecting Canadians' energy requirements*. In September of 1974 a new uranium export policy was announced. This policy assures that uranium supplies adequate to fuel operating and committed nuclear power stations in Canada will be available before any exports are allowed. Similarly, crude oil exports to the United States are being phased out in order to extend the period during which domestic oil reserves will be available for Canadians. Over the past year, substantial quantities of western Canadian oil have been "shut-in" in order to protect future supplies for the Montreal market. With the completion of the Montreal pipeline in the spring of 1976, western Canadian oil will begin flowing to Montreal and, when normal operating capacity is attained, it will displace about 250 000 barrels/day of imported oil. In an emergency, the capacity of this pipeline can be increased to 350 000 barrels/day, about 45% of total imports of crude oil in 1975. Over the medium-term, as western Canadian oil reserves continue to decline, new sources of supply will be required if this pipeline is to continue to serve the Montreal market. In the future the pipeline may have to be reversed to deliver oil from Montreal to Ontario markets, and it has been designed with this in mind. Through the next 5-7 years, however, the ability to provide domestic oil to Montreal refiners reduces substantially the risks that Canadians would face should international oil supplies be curtailed.

Chapter 5. FEDERAL-PROVINCIAL CONSIDERATIONS

Under the terms of the Canadian constitution, control over energy resources within provincial boundaries is vested in the governments of the provinces concerned. Similarly, many of the actions necessary to implement energy policies, including energy conservation programs, lie within provincial jurisdiction. It is clear, therefore, that a viable national energy strategy requires consultation and constructive cooperation with and among provincial governments. This has become obvious in the deliberations over the price and supply of western Canadian oil and gas reserves in the past two years, but it is no less true with regard to coal and to electricity. Electricity currently accounts for about one-third of total Canadian primary energy requirements and its relative importance will increase in the future. The generation and distribution of electricity has traditionally been a responsibility of provincial governments, in most provinces being provided by public utilities financed under provincial guarantees. In this area, cooperation among provinces is essential to realize the potential for the effective use of electrical energy.

The formulation of national coal policies, which requires close federal-provincial coordination, has been delayed over the past two years for several reasons. The exact extent of economic coal reserves in western Canada is still uncertain. Although a joint federal-Saskatchewan inventory program is nearing completion, similar programs in Alberta and British Columbia have been delayed for a number of reasons. In addition, the Province of Alberta has declared a moratorium on coal development in the Eastern Slopes region, and both Alberta and British Columbia are formulating new provincial coal policies. Delays in the formulation of provincial and national policies have been an element in delaying the potential movement of western Canadian coal to central Canadian markets.

Over the past two years, federal-provincial cooperation in energy matters has been increasing in a number of ways, for example through federal financial assistance for provincial electrical projects, joint resource assessment programs, combined research and development efforts, and joint participation in specific energy development projects. A number of these efforts have been noted above. There have also been areas where federal and provincial policies have been temporarily in conflict, to the detriment of Canadians generally: this has been most notable with regard to the fiscal systems applicable to the petroleum industry in Canada and has recently occurred with regard to the long and variable price freezes on petroleum products introduced by several of the consuming provinces.

In the summer of 1975, in response to differing views as to inventory stocks existing at the time of crude oil price increases, several consuming provinces introduced extended price freezes on petroleum products. These price freezes

led to inequities between provinces; they endangered, in some instances, the cash flow position of the industry; and they threatened to put at risk the agreed policy of a single price for crude oil in Canada. Federal-provincial discussions are currently underway in an effort to resolve these issues, and the federal government is confident that mutually satisfactory arrangements for dealing with existing inventory stocks can be agreed.

It appears that the disagreement over fiscal systems that has taken place over the past two years has been resolved satisfactorily. Its resolution, however, has emphasized the need for a greater degree of coordination and cooperation among provincial governments and between provincial governments and the federal government in energy policy planning. The federal government has welcomed the formation of the Inter-Provincial Advisory Committee on Energy (IPACE) as a positive and constructive force for federal-provincial cooperation in energy matters.

Oil and Natural Gas Revenues: Fiscal Considerations

To understand the controversy that has occurred over taxation and revenue sharing, it is necessary to review the principal changes in fiscal systems that have taken place. These principal changes are summarized here and a more detailed review is included in Annex II. Prior to 1972 the taxation policies of the federal government offered substantial incentives to the petroleum industry in Canada. The effect of these measures was such that by 1972 only a small number of producers had paid any federal tax at all. From 1947 to the end of 1972, total corporate income tax paid by the petroleum industry amounted to about $840 million, of which $700 million went to the federal government and about $140 million was collected by provincial governments. Over the same period, total revenues paid by the industry to provincial governments, through royalties, bonus payments, lease payments and other charges, amounted to about $5 billion. Virtually all of these revenues went to Alberta, Saskatchewan and British Columbia, with the bulk accruing to Alberta.

This favourable tax regime, together with the market protection afforded by the National Oil Policy of 1961, contributed to the rapid expansion of the Canadian petroleum industry. By the late 1960's it was becoming apparent that the industry had matured to the point where it could continue to grow and develop with a lesser degree of federal tax incentives. In 1971, when the Canadian income tax system was reformed, changes were introduced to reduce the relative tax advantages of investment in the petroleum industry, and to make the continuing tax incentives more efficient.

As the price of oil rose through 1973 the governments of the producing provinces became concerned that their revenue-collecting mechanisms were no longer appropriate. This concern was heightened after the substantial increases in international oil prices that occurred in the fall of 1973. In late 1973 and early 1974 fiscal regimes in the three producing provinces were altered so that the

provincial governments would appropriate the bulk of future price increases for oil and natural gas. The effect of these changes under the then-existing corporation income tax system, was to erode the federal tax base.*

During the period between the beginning of tax reform on January 1, 1972 and mid-1973 the federal government's share of oil and gas production profits was about 5 to 5½%. The provincial share, including royalties and corporation taxes, averaged 22%. At the end of 1973, the federal government could anticipate that about 18% of future production profits during the 1970's would accrue to the federal treasury as domestic prices were permitted to rise over time. Provincial governments, however, responded to appropriate most, and in some cases all, of the price increases. These actions, reflected in the provincial fiscal systems that existed in early 1974, would have reduced the federal share of future production profits from an anticipated 18% down to 9%, while the provincial share would have increased from about 22% to 49%.

The appropriate distribution of the "public" share of revenues accruing from unanticipated price changes is a difficult and contentious issue. The producing provinces maintain that they are entitled to the bulk of such revenues in recognition of their ownership rights over a finite and depleting resource. The federal government has never disputed this claim, but has consistently maintained that a reasonable share—certainly more than 9%— of the revenue generated by a healthy and mature petroleum industry should accrue to all Canadians, particularly in view of the incentives that had been given in the past. The petroleum industry, as other Canadian industries, should contribute through the corporation tax its fair share of the cost of national government. To the extent that it does not, the relative tax burden on other corporations and on individuals would be disproportionately high.

In May of 1974 the Minister of Finance introduced a budget that contained measures to guarantee a reasonable share of petroleum industry revenues for the federal government, on behalf of all Canadians. The Government was defeated in the House of Commons in May and no action with regard to those proposals took place. Following the consequent election and subsequent discussions with the provinces and the industry, a further budget was introduced in November of 1974.

The most contentious feature of the November budget, which had characterized the May budget as well, was the disallowance of the deductibility of provincial royalties by industry for income tax purposes. The non-deductibility

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* For example, with oil at $3.80 per barrel Alberta royalties amounted to about 84¢ per barrel. When the price of oil increased to $6.50 Alberta royalties per barrel increased to about $2.45. Although the price increased by $2.70 per barrel, the corporation income tax base for oil produced in Alberta increased by only $1.09, because royalty payments were deductible for income tax purposes. In Saskatchewan and British Columbia, where virtually all of the increase was appropriated by provincial governments, the corporate tax base remained unchanged despite the increase in price. (See Annex II.)

of royalties, together with the reduction in the federal tax rate to 25%, effectively left the federal government with a share of production profits that would be on the order of 19%, about the same relative share it had expected to receive under the fiscal systems that existed at the end of 1973.

In presenting the November budget the Minister of Finance noted that the federal government had drawn back from many of the provisions in the May budget. He invited provincial authorities to reconsider their fiscal regimes in responding to the needs of the industry and the nation. In December of 1974, the Premier of Alberta announced a major program to spur exploration and development, principally within Alberta, and to reduce the tax burden on the petroleum industry. Saskatchewan and British Columbia also introduced measures to rebate a portion of the increased tax liabilities arising from the non-deductibility of royalties.

Finally, in June of 1975 the Government of Canada introduced two additional modifications to the taxation system. These modifications recognized the special position of the provinces in respect of resources and met, to a degree, the request for some form of deductibility of provincial levies. In addition, they reduced the anticipated federal share of resource revenues and, at the same time, increased substantially the incentives to explore for and develop new petroleum resources. Partly in response to these proposals, Alberta reduced its effective royalty rate for oil from 65% to 50%, on that portion of the price between $6.50 and $8.00.

With current federal and provincial fiscal systems, it is estimated that from 1976-80, as oil and natural gas prices increase, the petroleum industry will retain a little more than 40% of production profits. About 17% will accrue to the federal government through the corporation income tax and 43% (including land and lease payments) will flow to the governments of the producing provinces. The evolution of fiscal systems over the past two years, in terms of anticipated average shares, is depicted in Table 1.

The public debate over revenue sharing has raised a number of issues with regard to the adequacy of industry's share, the disposition of the government share, and the nature and use of revenue accruing from the oil export charge. These are complex issues that require clarification.

Adequacy of Industry's Share

The fiscal changes that were introduced were intended to achieve a distribution of the unanticipated revenues arising from higher price that would: first, leave the industry with a competitive rate of return and with sufficient cash flow to meet its financial obligations and to undertake the exploration and development Canadians require and expect; second, allow an appropriate return to the producing provinces in recognition of both their rights of ownership and the depleting nature of their resources; and third, preserve a reasonable share of the resource revenues generated by a healthy and mature petroleum industry

Table 1

Anticipated Distribution of Revenues from Oil and Natural Gas

	End-1973	*Early-1974*	*Current Systems*
Industry Share	57%	42%	40%
Provincial Governments	25%	49%	43%
Federal Government	18%	9%	17%

NOTES: These reflect averages over the period to 1980 under the assumption that the prices of domestic oil and natural gas continue to increase towards international levels. The provincial share includes land and lease payments. The numbers shown for industry and provincial governments are averages and will differ for individual companies and particular provinces. In particular, these shares will depend on the degree to which active exploration programs are maintained (see Figure 2).

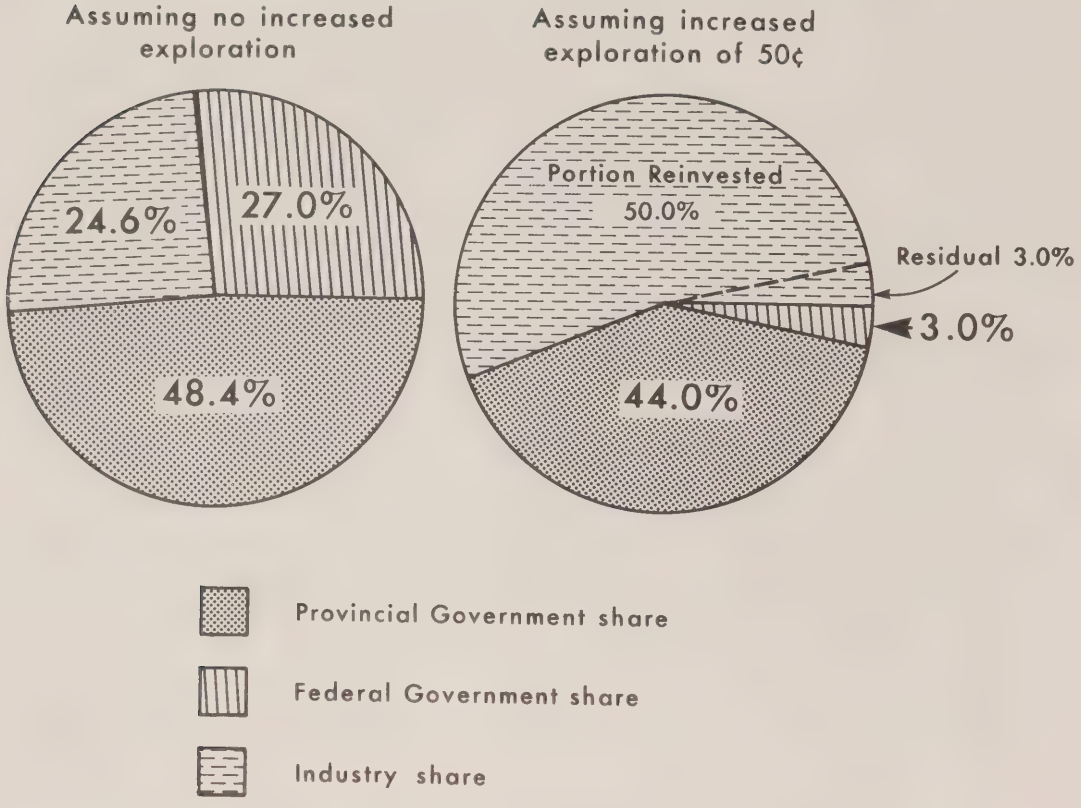
Under "Current Systems" the industry's share is based on an assumed level of exploration and development expenditure. The industry's share (for the industry as a whole), therefore, is to be divided between:

Reinvested Funds:	25%
Residual Funds:	15%
	40%

for the federal government on behalf of all Canadians. It has been alleged by some that the industry is the recipient of large windfall gains, that it is involved in a "public rip-off". At the same time, others have argued that the bulk of the price increase is flowing to governments and that industry is not getting enough. These conflicting views have been confused further by the flow of statistics indicating the net return per barrel, shares of production profits, and annual rates of return on assets or sales in relation to rates of return in other activities. All of these numbers are subject to a wide variety of interpretation. Another way of addressing the problem is to ask "how much is enough?". For example, the per barrel return (after lifting costs) to a company producing oil in Alberta at a wellhead price of $8.00 may range from $1.80 to more than $4.00. The precise return, or netback, will depend on such factors as the productivity of the well, whether the oil is "old" oil or "new" oil, and the amount of reinvestment taking place. Similarly, the anticipated 40% share of production profits referred to above is very much an average. Companies actively involved in exploration will receive more and other companies will receive less. It is to be emphasized that this 40% share of production profits accruing to industry includes the funds which are being reinvested in exploration for and development of new reserves.

The magnitude of the incentive to explore is indicated in Figures 2 and 3. Figure 2 shows the manner in which the revenue from an increase in $1.00 per barrel in the domestic oil price will be distributed with current fiscal systems.

Figure 2. Distribution of incremental net revenues from an increase of $1.00/bbl in crude oil



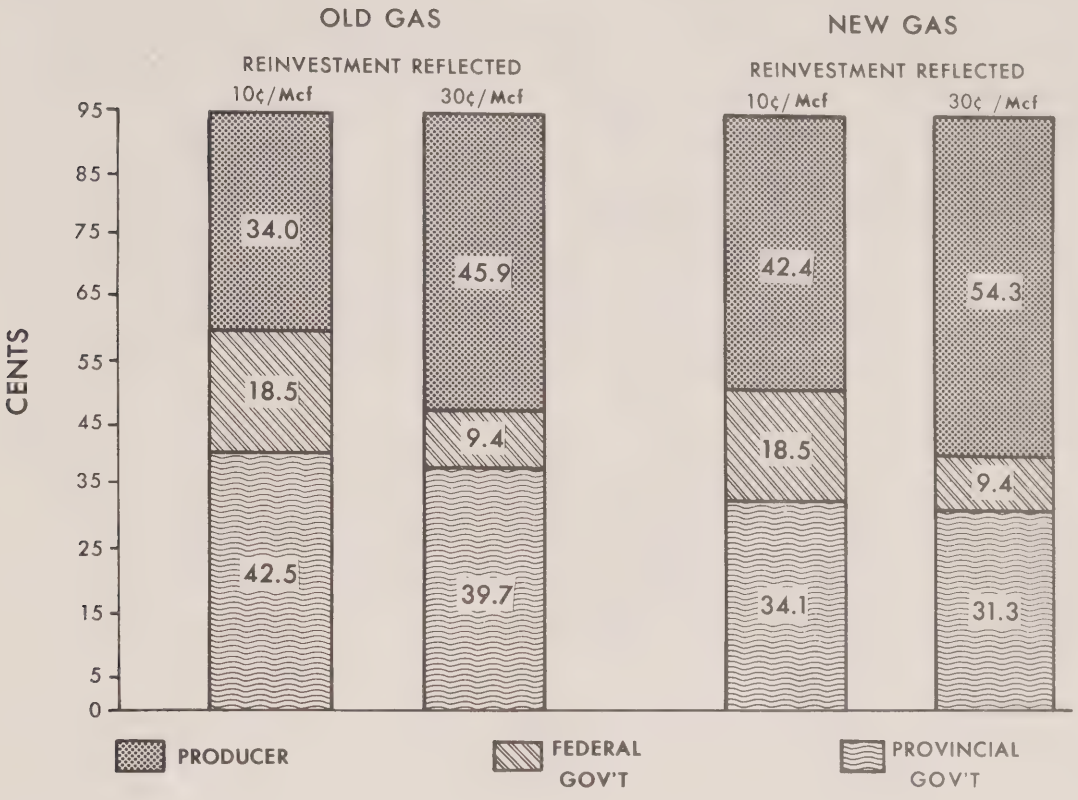
NOTE: The shares shown for industry and the provincial governments, with reinvestment, do not reflect specific provincial incentive programs (for example, drilling credits).

In the absence of additional exploration expenditures by industry, the federal government would collect 27% of the additional production profits generated. With increased exploration of 50¢ per barrel, the federal share will fall to 3%. The provincial share will fall as well and the industry's share will rise from about 25% to 53%. If exploration expenditures increase by 57¢ per barrel when oil prices rise by $1.00 per barrel, the federal share of the additional production profits generated could fall to zero. These cases are merely illustrative to indicate the built-in incentives of the federal fiscal system.

Figure 3 indicates the current disposition of the average field price (95¢/Mcf) for natural gas in Alberta. Increasing investment from 10¢/Mcf to 30¢/Mcf could generate an immediate additional flowback of about 12¢/Mcf for both old and new gas. This tax-induced flowback is independent of the yield of the additional investment.

To understand what constitutes an "appropriate" netback to the producer it is necessary to consider the fiscal system and wellhead price together. The netback that these two factors yield should accomplish three objectives. It should produce a rate of return on existing assets that is competitive. It should

Figure 3. Range of producer returns on Alberta natural gas, January 1, 1976



yield a prospective rate of return on future investments that provides sufficient incentive to explore and develop. And, finally, it should produce a cash flow that meets the requirements of the industry for internally generated funds.

The rate of return on existing investments must be interpreted in a "life-cycle" sense. The evolution of the petroleum industry is generally characterized by a long delay between the time investments are made and the time that those investments produce revenues. For example, there are substantial remaining recoverable reserves of oil and natural gas in the western sedimentary basin (about 7-8 billion barrels of conventional crude and equivalent and about 57 trillion cubic feet of natural gas). In assessing the rate of return on the investment that has already been made to find and develop these reserves, it is necessary to consider that this substantial remaining inventory will be produced with relatively little additional investment. The appropriate rate of return to focus on is the discounted cash flow (dcf) rate of return which, on a life-cycle basis, takes full account of future production in relation to past investments.* On this

* "Although there are many other economic criteria such as payout, which are also used, none is relied on quite so heavily in oil industry investment analysis as the dcf rate of return." *Economics and Financial Needs of the Oil and Gas Industry*, prepared by the Canadian Petroleum Association, February 1975, p. 8.

basis, current calculations suggest that the dcf rate of return on the production of resources in the producing provinces will be in the range of 12 to 13% after taxes if future price levels for domestic oil and natural gas continue to move towards international levels and reflect future rates of inflation. The federal government believes that this constitutes a reasonable and competitive rate of return for the petroleum industry with regard to known reserves.

What about anticipated rates of return on new supplies? Consideration of this issue demands explicit recognition of the large element of risk involved in certain exploration activities and the very high costs of such activity in Canada's frontier areas. One must also distinguish new supplies in the frontier from additional supplies in the western sedimentary basin. With regard to the latter, provincial fiscal regimes differentiate between "old" and "new" oil and gas, providing greater incentives for new production and, as well, offering direct incentives for continued exploration in the province. The federal corporation income tax is also structured in a manner that rewards those companies that continue to explore, regardless of whether the exploration takes place in the provinces or in the frontier areas of Canada. In essence, the federal government, through its incentives for exploration, is sharing the exploration risk with the industry.

With regard to frontier exploration, it is the view of the federal government that the current price does not afford sufficient incentive for the level of activity that will be necessary to assess adequately the magnitude and location of frontier resources, and to develop them. The great bulk of our potential frontier resources cannot be discovered, produced and delivered to markets and yield a commercially attractive rate of return at current Canadian prices. This appears to be the case even with no government participation in revenues. Federal legislation concerning Canadian oil and gas land regulations, to be introduced to Parliament shortly, will be framed in a manner that recognizes this problem. Royalties will be nominal and sufficient flexibility will exist so that pools of marginal value can be developed through lower royalties while very large productive pools will be assessed a higher tax burden. The basic incentive problem with regard to frontier production, however, is not one which can be corrected by fiscal modifications. What is required is a market price sufficient to cover high-risk, high-cost exploration and development.

The final criterion that must be assessed in judging the adequacy of industry's share is the degree to which cash flows correspond with requirements for internally generated funds. Current estimates suggest that, with existing fiscal systems and prices that gradually increase towards current international levels, the industry will retain, after taxes and royalties, in excess of $3 billion per year (in 1975 dollars), on the average, over the next five years. This money will be available for reinvestment and for financial costs. It is consistent with anticipated exploration programs and, in fact, leaves some room for upward revisions of spending plans, or to cope with inflationary trends which have been higher than the national average.

In retrospect, it is clear that the fiscal systems that existed in mid-1974 left the industry in a relatively unhealthy position. In particular instances, the combined effect of federal and provincial modifications led to anticipated rates of return that were too low and to cash flows that were inadequate. More generally, the fiscal revisions that took place in 1974 fostered a climate of uncertainty that was not productive. The modifications to both provincial and federal fiscal regimes that took place in late 1974 and 1975 have resulted in fiscal systems that are equitable and that will, as prices rise, provide the rates of return, cash flows and incentives necessary for industry to maintain a high level of exploration activity. The onus is now on the industry to demonstrate that its share of revenue is being productively and efficiently utilized to discover and produce additional Canadian resources.

Disposition of the Government Share

It has been alleged that governments are capturing the bulk of the revenues arising from price increases for oil and gas, and using these revenues for "general purposes" rather than to develop and produce new energy for Canadians. The largest part of the increase in revenues flows to provincial governments and in particular to the Government of Alberta. The federal government rejects the principle that the nature of the expenditures it makes should be determined by the sources from which revenues are collected. Specific expenditures must be based on national priorities and not necessarily related to specific revenues. Nevertheless, energy spending is a priority and the Government of Canada has undertaken a number of new and substantial commitments for energy-related expenditure.

It is difficult to compare the additional federal revenues that will result from price increases and additional energy-related expenditure. In part, this is so because of the difference between cash and accrual bases of accounting for funds. For example, although corporation tax liabilities increased in 1974 due to higher oil prices, in many instances the additional payments are only now being collected. More fundamentally, however, it is not clear how "additional" energy-related expenditure should be defined in this context. Federal government decisions to spend in the energy area are not based, and should not be based, on higher revenues through higher prices.

Rough estimates suggest that the effect of price and fiscal changes through 1974 and 1975 was to increase federal corporation tax accruals from the petroleum industry by about $970 million. Increased federal liabilities for equalization payments to provinces resulting from higher provincial royalties, together with the increase in energy-related expenditures in fiscal years 1974-75 and 1975-76, amounted to almost $600 million, leaving an estimated surplus of slightly less than $400 million on this basis.

These calculations do not include the revenues from the export charge on oil or the special excise tax on motor gasoline. Nor do they include the

federal liabilities for oil import compensation. Over the period up to and including fiscal year 1975-76, it is estimated that accrued liabilities roughly balanced accrued revenues (See Figure 34).

Although the increase in income tax accruals has not been matched by increased energy-related expenditures, it must be remembered that, because of delays in tax payments, the bulk of the increased corporation tax liabilities has not yet been received as income. As well, in addition to the increased expenditures made over the past two years, the Government of Canada has committed itself to financing a number of new energy-related programs. Over the next four fiscal years these new commitments are expected to entail expenditures in excess of $2.8 billion, including about $425 million for electrical transmission systems, $850 million for the development of nuclear power (including the La Prade heavy water plant at La Prade, Quebec, and the nuclear station at Point Lepreau, New Brunswick), and about $750 million for oil and gas development (including participation in Syncrude and federal equity funding of Petro-Canada).

Revenues from the Export Charge

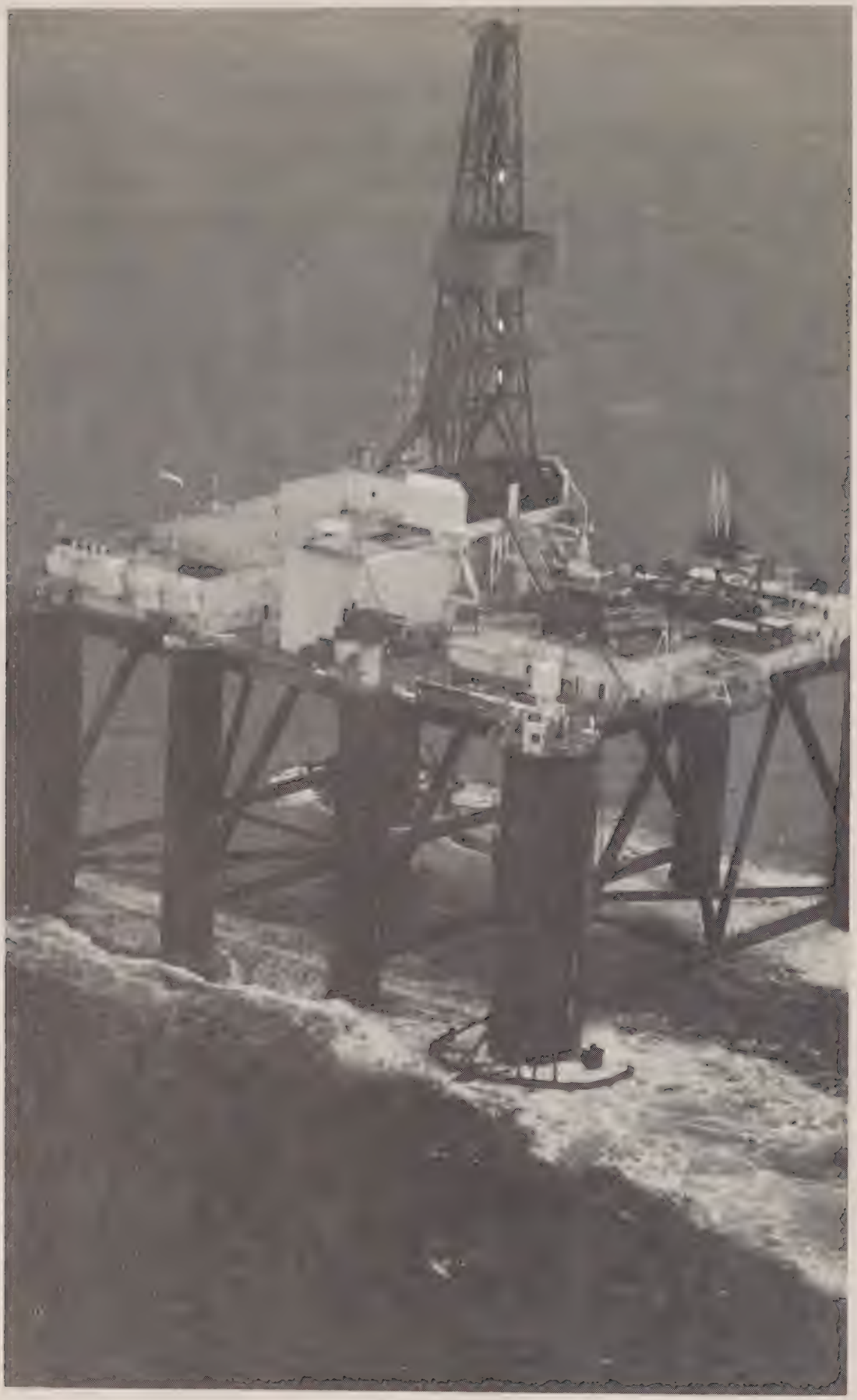
The Government of Canada has been criticized by the governments of the producing provinces for its failure to include the revenues from the export charge on oil in its calculations of the federal government share. This criticism is based on the proposition that the revenues from the export charge, which in 1975 amounted to $1.2 billion, are being appropriated by the federal government at the expense of the industry and the governments of the producing provinces. While these revenues do flow initially to the federal government, all of this money as well as that from the special excise tax on gasoline is paid in the form of a subsidy, equivalent to the differential between the price of imported oil and the Canadian price, in order to allow the petroleum industry to sell imported oil to eastern Canadian consumers at the agreed Canadian price. This policy has been adopted specifically to allow Canadians to adapt to higher energy costs on a gradual basis.

The governments of producing provinces, the Government of Canada and the petroleum industry are all subsidizing Canadian oil consumers by maintaining the price of Canadian oil below international prices, and subsidizing eastern Canadian consumers directly by the adoption of a single-price policy for crude oil in Canada. The amount of this direct and indirect subsidy in 1975 was almost $5 for every barrel of oil consumed in Canada, or roughly $3 billion. The subsidy paid directly to Canadian consumers of imported oil, in eastern Ontario, Quebec and the Atlantic Provinces, was $1.4 billion in 1975.

The single-price policy and the resulting subsidy were agreed to jointly by the governments of all provinces and the Government of Canada. Consistent with this agreed policy, the option existed of eliminating exports entirely and redirecting Canadian oil to Canadian consumers at the agreed price. It made much more sense, however, to utilize existing distribution systems and to

transfer the revenues arising from the export charge rather than physically transferring the oil. This strategy was accepted by First Ministers in March of 1974. Thus the subsidy arrangement is based on a mutually agreed policy, and the revenue from the export charge should be viewed not as a federal source of funds but rather as a transfer payment from exporters of Canadian oil to importers of oil to Canada.

Horsehead pumps at Cold Lake, Alberta—(Imperial Oil Limited photo).



An offshore drilling rig.

Section III

CANADIAN ENERGY PROSPECTS: 1976-1990

Chapter 1. INTRODUCTION

Canadians are at a crossroads with regard to energy. Traditional supplies of oil and natural gas from the western sedimentary basins are declining, and potential resources of unknown dimensions from Canada's frontier areas are assuming a much larger role in policy planning. The planning process is constrained, however, by uncertainties as to the availability of frontier resources; the adequacy of the technology necessary to deliver whatever supplies become available; the social and environmental impacts of northern resource development; and the costs and prices necessary to deliver those potential supplies, when found, to markets in southern Canada. With regard to the oil sands, although substantial resources are known to exist, significant technological advances are necessary if those resources are to become available at competitive prices.

The dimensions of our uncertainty extend beyond oil and natural gas. The share of coal in Canadian energy consumption has been declining for the past 25 years. In 1950, coal supplied almost 43% of Canadian energy requirements compared with slightly less than 9% in 1974. Canadian production of coal declined from a peak of about 19 million tons in 1950 to a level of about 10 million tons in 1962. It has since expanded to almost 28 million tons in 1975, driven essentially by export demand from Japan for metallurgical coal. Canada has extensive and varied resources of coal and, while detailed knowledge of their quality and recoverability is inadequate, enough is known to be confident that current levels of proved reserves would allow substantial increases in annual production rates. The marked increase in the price of oil has reestablished coal as a competitive energy source, and its potential for future thermal generation of electricity, along with advances to allow the use of coal in a converted form through such processes as gasification, suggest that coal could play a significant role in Canada's energy future. The degree to which coal production can be expanded will depend on the success of planning and co-ordinating the necessary developments. Constraining factors include rapidly escalating costs of production, the availability of labour for mining, the environmental impacts of accelerated coal production and utilization, and the adequacy and cost of transportation systems for delivering coal from western Canadian mines to eastern markets. Future policies of the provincial governments with regard to the pace at which they will allow their coal resources to be developed and the fiscal regimes they intend to apply to this resource will be instrumental in determining the degree to which such constraints can be overcome.

Unlike coal, electricity has been continuously increasing in relative importance as an energy source and in 1974 it provided almost 34% of total primary energy consumption. Hydroelectric and nuclear electricity accounted for almost 80% of the total electric power produced in 1974, with the remaining 20% generated from coal, oil and natural gas. Like coal, the large increases in oil price have enhanced the competitive position of electricity and made it relatively more attractive, except for the electricity generated from oil. In 1973,

it was estimated that electricity would continue to grow more rapidly than other energy sources and would supply about 40% of total Canadian energy requirements by the end of the century. From 1960 to 1970 the rate at which the market share of electricity grew was constrained by the availability of large volumes of natural gas at relatively low prices. It is conceivable that the use of electricity will grow more quickly relative to total energy in the future because of the higher prices that will prevail for other energy sources. At the same time, however, it must be recognized that electricity prices themselves are escalating rapidly, due to the large amounts of capital required for new generation capacity (particularly for nuclear and hydroelectric power), high rates of interest, and rapid cost escalation in power plant construction. The degree to which electric power will be able to maintain a competitive price advantage relative to oil and natural gas will depend on the degree to which future price increases for electricity can be constrained.

Similarly, Canadians are in the midst of a transition period with respect to the manner in which future electricity supplies will be generated. The federal government has, for almost thirty years, actively supported the development of Canadian nuclear power technology and an indigenous nuclear industry. The development work of Atomic Energy of Canada Limited and Ontario Hydro has led to the introduction of the CANDU series of reactors into operational service in the electrical systems of Ontario and Quebec and to the current construction of the initial Point Lepreau nuclear station in New Brunswick. The CANDU reactor has the advantage that it is fuelled by natural, rather than enriched, uranium. This keeps its operating costs at a relatively low level even in the face of marked increases in fuel prices. On the other hand, nuclear reactors have high capital costs in relation to fossil-fired plants.

In late 1975, Ontario Hydro estimated that it would add about 20 000 megawatts (MW) of nuclear capacity to its system by 1990; it projected that, in 1990, 57% of electricity use in Ontario would be supplied by nuclear power (compared with 15% in 1974)*. Also in October of 1975, Ontario Hydro estimated its total electrical expansion plan, through the next ten years would require almost $19 billion, expressed in constant (1975) dollars.** This compares with total capital expenditures of $7.9 billion over the past ten years, also expressed in 1975 dollars. In February of 1976, in response to difficulties in securing required financing, Ontario Hydro deferred its expansion program and revised its projection of additional nuclear capacity from 20 000 MW to 17 000 MW by 1990. In addition, there has been increasing public concern expressed as to the safety of nuclear plants, the security of potentially dangerous material, and other problems associated with the disposal of radioactive waste. Such concerns, which are discussed below, could lead to some uncertainty as to the pace of expansion of the Canadian nuclear program that the public may

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* R. M. Dillon, "Ontario: Towards a Nuclear Electric Society?", presented to the Canadian National Energy Forum, October 16, 1975, p. 4.

** *Ibid.*, page 15.

find acceptable. The Government of Ontario has recently appointed a Royal Commission on Electrical Power Planning to enquire into the long-range planning of Ontario's electrical power system.

A further consideration that has recently received a great deal of attention is "net energy", that is, the difference between the amount of energy it takes to build and operate an energy production process and the amount of energy produced by that process. Such analyses take account of the energy consumed in mining and transporting the primary materials, in fabricating them and building and fuelling the plant itself. Stated simply, it takes energy to produce energy. In many ways the analysis is similar to economic accounting and simply reflects the fact that there is an energy investment that is often overlooked when considering plans. Preliminary calculations suggest that the proportion of energy that must be invested in order to produce one unit of energy for consumption has been increasing over time. Such analysis is not a substitute for conventional economic analysis, but it is useful in providing supplemental information. For example, preliminary results suggest that, while all of the major supply options open to Canada through the next fifteen years would be significant producers of net energy, various growth paths that might be followed in development of, for example, a nuclear power program could have significantly different implications for the net energy return *during the construction phase.*

These factors suggest very strongly that the energy supply system in Canada is in the process of structural changes that will have far-reaching implications. This observation is no less true of the demand for energy. For the past fifteen years, in response to gradually falling energy prices and continued high rates of population increase and economic growth, energy consumption in Canada has grown fairly smoothly at about 5.5% per year. There are indications that higher energy prices, lower rates of population growth, and active energy conservation programs will lead to modifications of the ways in which energy is used, with the prospect of much lower rates of increase in energy consumption than we have observed in the past.

To provide an understanding of the nature of the problems that we are likely to face and the issues that must be addressed over the next fifteen years, two "scenarios" are presented. These scenarios deal with the evolution of future Canadian demands for energy, in relation to possible future supplies and with reference to implications for general economic performance. It must be emphasized that all projections of future events are uncertain and these are no exception. Critical areas where current uncertainties are most pronounced include the magnitude and distribution of Canadian hydrocarbon resources and the future costs of additional hydrocarbon supplies; the magnitude of the reduction in future Canadian energy demand growth in response to higher prices and to energy conservation programs; the development of technology affecting the production, distribution, conversion and utilization of energy; and future price levels for international oil. In view of these uncertainties the projections themselves must, at this point in time, be regarded as indicative

rather than firm. They are continuously being refined and revised as new information becomes available, and through the balance of this year a number of studies will be published which will explain in detail the manner in which they have been derived and their sensitivity to key assumptions. Although the numerical forecasts may vary, however, the qualitative implications of the scenarios themselves can be regarded as accurate indications of the nature of the energy planning problems we are likely to experience in the next fifteen years.

One final point must be made. Neither of the scenarios presented here "has" to occur. Indeed, they are put forward as likely developments *in the absence of new government initiatives*. They have been developed to indicate the nature of the anticipated problems and, in this sense, *to serve as a framework for the development of appropriate policies that can overcome such problems.*

The switching yards of Churchill Falls generating station.

Chapter 2.
ENERGY DEMANDS: 1976-1990

The projections of future Canadian energy demands presented here differ from most previous projections in two important respects. First, the demand for total energy is linked explicitly to assumptions about future demographic and economic activity, including future energy prices. Second, the demand projections are internally consistent, in the sense that, once total energy requirements are estimated for each end use sector of the economy, the demands for all energy sources are determined on a "market share" basis which ensures that the sum of the energy sources equals total energy demands.

The "total energy" approach to forecasting that has been adopted here is preferable to an approach which builds up total demands on a commodity-by-commodity basis since it recognizes that the essential demand on the part of producers and consumers is not necessarily for specific fuels but rather for energy. The demand for energy is related to the production and consumption of goods and services. Whether such energy will be provided by oil, gas, coal or electricity depends upon a number of factors such as relative prices, technology and availability. In general terms, demands for individual energy commodities are highly substitutable in particular uses: homes can be heated by oil, natural gas, or electricity generated from any one of a number of fuels. The problem with building up energy demand projections from specific commodity forecasts is that the sum of the individual projections may yield total energy requirements that are not consistent with underlying demographic and economic trends. Inadequate attention may be paid to the degree to which one energy source can be substituted for another.

The projections presented below have been derived from an analytical framework developed in the Department of Energy, Mines and Resources. This framework, which is available upon request to interested researchers, projects energy demands on the basis of historical relationships between energy use and demographic and economic activity. However, it does allow substantial scope for the adjustment of these historical relationships on the basis of anticipated reactions to changing energy prices and technology. A forthcoming study will describe in detail the structure of this forecasting framework, the nature of the key assumptions which it requires, and the sensitivities to variations in those assumptions of the demand projections it generates.

With regard to future Canadian energy price levels, two alternative assumptions have been made:

*"**Low-Price" Scenario:** In this set of projections it is assumed that the controlled price of oil in Canada remains at end-1975 levels in constant 1975 dollars. It increases only at the general rate of inflation, and does not increase relative to the prices of other goods and services. It is further assumed that the price of natural gas increases to "commodity*

equivalent" value with crude oil ($1.52/Mcf at the Toronto city-gate in 1975 dollars) in the latter part of the 1970's, and that the prices for electricity and coal also remain constant, in real terms, at end-1975 levels.

***"High-Price" Scenario:** In this scenario, it is assumed that oil prices increase relatively faster than the prices of other goods and services until about 1978, when they reach a level that is roughly equivalent to the **current** international price (about $13.00 per barrel landed in Montreal in 1975 dollars). Prices for electricity and coal are assumed to increase at the same rate as oil prices and the price of natural gas is again assumed to adjust to "commodity-equivalent" value with crude oil ($2.25/Mcf at the Toronto city-gate, in 1975 dollars) by the late 1970's. After 1978, all energy prices are assumed to increase at only the general rate of inflation. Expected future pricing relationships among competing energy sources are difficult to assess. This is an important aspect of potential interfuel substitution which is currently being investigated within EMR. Results will be reported in the previously mentioned study on energy demand to be published later this year.*

For each of these two scenarios, a range of energy demands is forecast, with the limits of the range determined by making alternative assumptions about expected economic activity through the next fifteen years. The lower end of the range assumes that potential economic growth in the 1980's slows markedly from the historical experience, reflecting a reduced rate of growth in the Canadian population, labour force and labour productivity. The upper end of the range is determined by assuming that, on average, demographic and economic trends through the 1980's will be similar to those observed in the 1960's. The major characteristics of these assumptions are displayed in Table 2.

Table 2

Major Assumptions Underlying Energy Demand Projections

	1974 Level	Average Annual Growth Rate (%) 1961–70	1976–80	1981–90**	1990 Level
Gross national product ($1971 billions)	108.8	5.2	5.4	3.6	203.0
Population (millions)	22.5	1.8	1.3	1.2	27.5
Households (millions)	6.7	2.9	2.7	2.1	9.8
Unemployment rate (%)*	5.4	5.0	6.3	5.4	5.9
Employment (millions)	9.1	2.8	2.8	1.7	12.7
Ratio of multiple dwellings to total housing stock*	.417	.363	.432	.458	.472
Personal disposable income/capita ($1971 thousands)	3.2	2.7	2.8	1.9	4.5
Industrial real domestic product (Index, 1971=100)	117.9	5.7	5.9	3.7	226.1

* Average annual level shown, rather than growth rate.

** These are the growth rates assumed for the "low" economic growth case; for the "high" case the average annual growth rates for the period 1961-70 were assumed to apply in the 1980's.

All differences between the two economic profiles occur from 1981-90. It is felt that the alternative growth paths used for each scenario bracket fairly accurately the feasible growth potential of the Canadian economy through this period.

Two further points should be stressed. First, the relationships used in projecting energy demands are more detailed than simple energy/GNP or energy/population ratios. In the residential sector, for example, energy demands depend upon such factors as personal disposable income, the number of households, the split between single and multiple housing, and the relative price of energy. Demands in the commercial sector also depend on the nature of the housing stock (since energy used by large multiple dwellings is priced at commercial rates and included as commercial demand) as well as the levels of retail trade and energy price. Industrial demands depend not only on price and industrial production but also on the capital/labour mix employed in the productive process. In general, the relationships used reflect the structural characteristics of the sector examined to the greatest extent possible.

Second, it must be noted that none of the projections presented below takes account of explicit energy conservation measures, although they do reflect a more efficient use of energy that might reasonably be expected to occur in response to higher energy prices. The relationship between the projections presented here and the federal government's energy conservation program are discussed in Chapter 4.

Total Energy

A summary of the possible future demands, based on results from the high-price and low-price scenarios, is presented in Table 3. In the high-price scenario, where it is assumed that the structure of domestic energy prices adjusts to current international oil prices, two alternative energy demands are presented which differ only after 1980 as a result of different assumptions about economic growth. From 1976 to 1980, this price scenario results in an average growth rate in energy demands of about 4.5% per year, a reduction of about 1% per year from the growth rate experienced during the sixties.

Comparing the high-price scenario with the low-price scenario, in which it was assumed that domestic energy prices, with the exception of natural gas, remain at end-1975 levels in real terms, indicates that, over the next 15 years, further price increases are likely to reduce the rate of growth of energy demands by about 0.5 percentage point per year. This would result in a level of energy demand in 1990 that is lower than that shown for the low-price scenario by about 6.5%, a little over one "quad".* This reduction in energy demand in the year 1990 would be roughly equal to 13% of total energy used in Canada

* A "quad" is equal to 1 000 trillion Btu's. One Btu is the amount of heat required to raise the temperature of one pound of water 1°F. Total energy consumed in Canada in 1975 is estimated at a little under 8 quads.

in 1975. Over the period 1976-1990, the cumulative reduction in estimated energy demands between the high-price and low-price scenarios would be about 8.2 quads. This reduction in possible future energy demands over a fifteen-year period is the energy-equivalent of 1.4 billion barrels of oil, an average of slightly more than 250 000 barrels per day for fifteen years.

Table 3

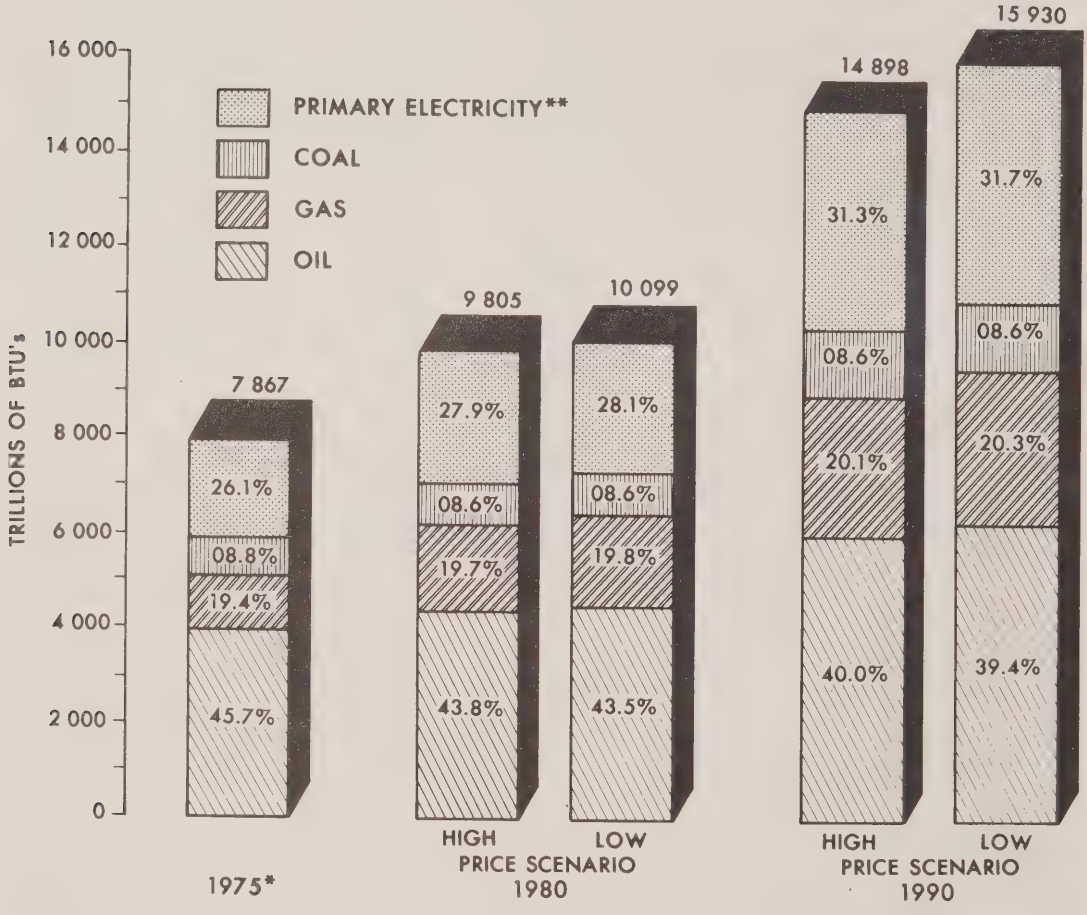
Energy Demand: Two Scenarios

	High-Price Scenario		Low-Price Scenario	
Economic Growth:	*High*	*Low*	*High*	*Low*
Trillions of Btu's				
Primary energy				
1975*	7 867	7 867	7 867	7 867
1980	9 805	9 805	10 099	10 099
1985	11 867	11 469	12 637	12 229
1990	14 898	13 472	15 930	14 449
Indexes (1975=100)				
Energy per capita				
1975	100.0	100.0	100.0	100.0
1980	116.6	116.6	120.1	120.1
1985	129.1	127.8	137.4	136.3
1990	148.2	141.6	158.5	151.9
GNP per unit of energy				
1975	100.0	100.0	100.0	100.0
1980	104.3	104.3	101.2	101.2
1985	112.7	110.1	104.2	103.3
1990	113.9	108.4	106.6	101.1
Average annual growth rates (%)				
Primary energy				
1976–1980	4.5	4.5	5.1	5.1
1981–1990	4.3	3.2	4.7	3.6
1976–1990	4.3	3.7	4.8	4.1
Energy per capita				
1976–1980	3.1	3.1	3.7	3.7
1981–1990	2.4	2.0	2.8	2.4
1976–1990	2.7	2.3	3.1	2.8
GNP per unit of energy				
1976–1980	0.8	0.8	0.2	0.2
1981–1990	0.9	0.4	0.5	0.0
1976–1990	0.9	0.5	0.4	0.1

* Estimate.

Also shown in Table 3 are some projected trends for energy demand per capita and the ratio of GNP produced to energy used. Energy use per capita is projected to continue to increase, but at a lower rate than it did in the 1960's, when it grew on average at about 4% per year. The decline in this growth rate can be attributed to the more efficient use of energy, stimulated by higher energy prices than were experienced in the 1960's. Over the 1976-1990 period it is anticipated that energy demand per person might increase on average by 2.3%-3.1% per year. The principal reason for the differences between the growth in energy per capita in the high and low economic growth cases is the difference in the trend to smaller households. Energy demands are more accurately related to the number of households than population. The higher rate of growth of energy/capita in the high economic growth cases reflects the more pronounced trend to smaller households.

Figure 4. Demand for energy by source: two scenarios

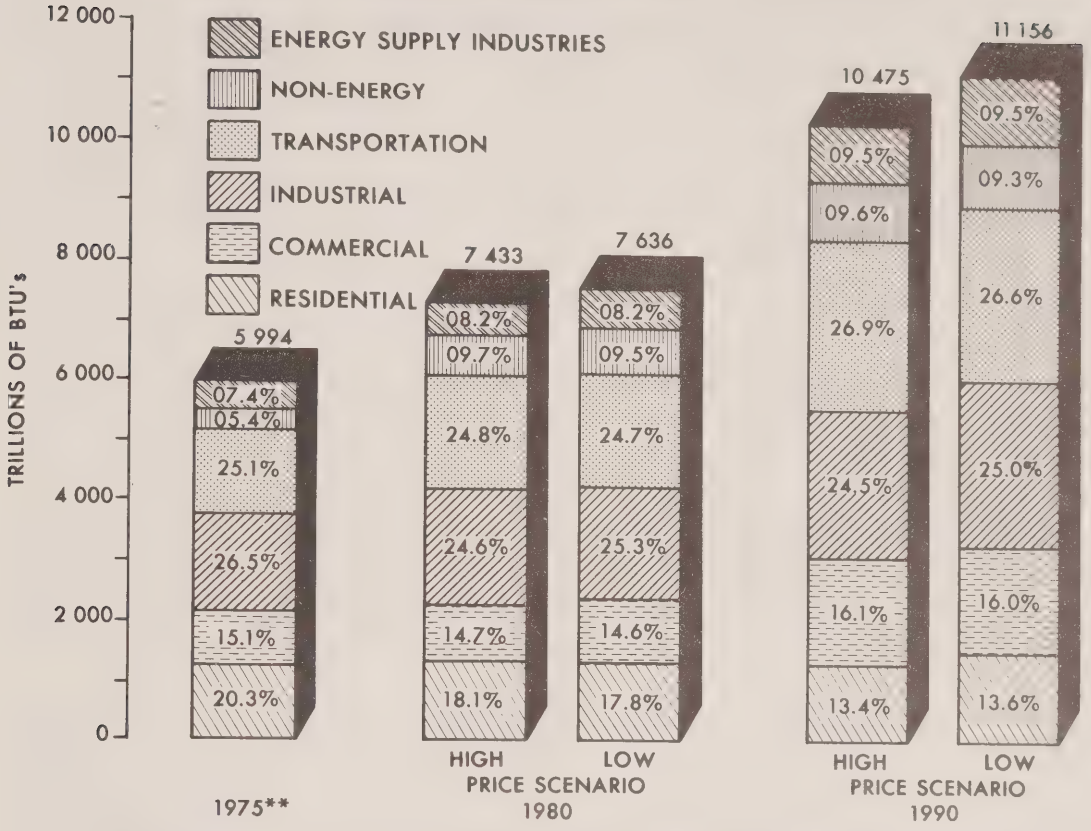


* Estimate.

** Primary electricity is hydro and nuclear valued at a fossil-fuel displacement value of 10 000 Btu/kilowatt-hour.

The ratio of GNP produced to energy used is a very rough measure of energy productivity. It must, however, be interpreted with some caution since the structural composition of both energy use and the GNP shift over time.

Figure 5. Demand for energy* by use: two scenarios



* The total energy shown is lower than the levels in Figure 4 as a result of valuing electricity at its output value (3 412 Btu/kilowatt-hour) rather than at the primary energy equivalent value of 10 000 Btu/kilowatt-hour.

** Estimate.

NOTE: Transportation demand does not reflect recently announced mileage standards for automobiles (see Figure 30).

Based on the structure of the economy as it was in the 1960's, it appears (from column 3) that the increases in relative energy prices that have already occurred could result in an average rate of increase in the "productivity" of energy of about 0.4% per year over the 1976-1990 period. This means that, on average, the rate of growth in GNP would exceed the rate of increase in energy consumption by 0.4% per year.* Further increases in relative energy prices, as in the high-price scenario (column 1), could lead to a further increase in energy "productivity" of about 0.5% per year. The two cases that assume lower economic growth (columns 2 and 4) suggest that energy productivity could grow much less rapidly with lower economic growth. This reflects possible changes in the structure of the Canadian economy, for example the continued trend to service industries where productivity is generally lower.

* From 1950 to 1960, due in large measure to the increasing efficiency that accompanied the transition from coal-based to oil-based energy use, GNP grew faster than total energy consumption by about 1.1% per year. From 1960 to 1974, on average, energy use in Canada grew about 0.3% per year more rapidly than GNP—the "productivity" of energy declined by about 0.3% per year.

The distribution of projected total energy demands among competing fuels is indicated in Figure 4. The proportions of total energy demanded in the form of oil, gas, coal and electricity are similar in both scenarios, since it has been assumed that relative prices of specific energy sources adjust to the energy price structure as determined by the price of oil in Canada. This approach has been adopted in view of current uncertainties with regard to future price profiles, particularly for electricity and coal. Future coal prices will depend, among other factors, on provincial government policies. Future prices for electricity will be influenced by the magnitude of expansion programs undertaken, the capital intensity of such programs and the way in which they will be financed, the cost of capital, prices of fuels (and fossil fuels in particular), and provincial regulatory processes. Work is underway within EMR to develop a better appreciation of possible future pricing relationships among oil and competing energy sources. For the purposes of these scenarios it has been assumed that relative price relationships among competing fuels will remain constant after a transitional period of about four years. To the degree that prices of electricity and coal increase less rapidly than we have assumed, they could, over time, capture a larger share of the energy market at the expense of oil and natural gas.

Figure 5 indicates the projected distribution of energy demands by use. Again, the distribution by end-use sector is relatively stable across both scenarios and over time. The share of the residential and industrial sectors is projected to decline over time as the relative importance of the transportation, non-energy use (mainly petrochemical) and energy supply sectors increases. Part of the decline in the residential sector is attributable to the relative increase in multiple dwelling units, many of which purchase energy at commercial rates and are accordingly classified in the commercial sector.

Oil

Projected demands for oil are presented in Table 4. In the low-price scenario, which assumes that the price of domestic oil only increases above the end-1975 level to keep pace with inflation, domestic demand for oil could increase by between 3.0% and 3.8% per year over the period 1976-1990. Phasing domestic prices to current international levels could reduce these growth rates to 2.6% and 3.4%, respectively. Such a move might reduce the demand for oil in 1990 by about 150 000 barrels/day and, over the period 1976-1990, the cumulative reduction in anticipated demand could be on the order of 475 million barrels of oil or an average of 85 000 barrels per day.

Projected oil demands, by use, are presented in Figure 6 for the high economic growth cases. Because the market shares of different fuels are assumed, for any given year, to remain constant between scenarios, there is relatively little difference between the scenarios for end-use demand for oil. Over time, however, the figure indicates that major shifts among sectors occur in both total energy and market share of oil. The fraction of total oil use falls particularly

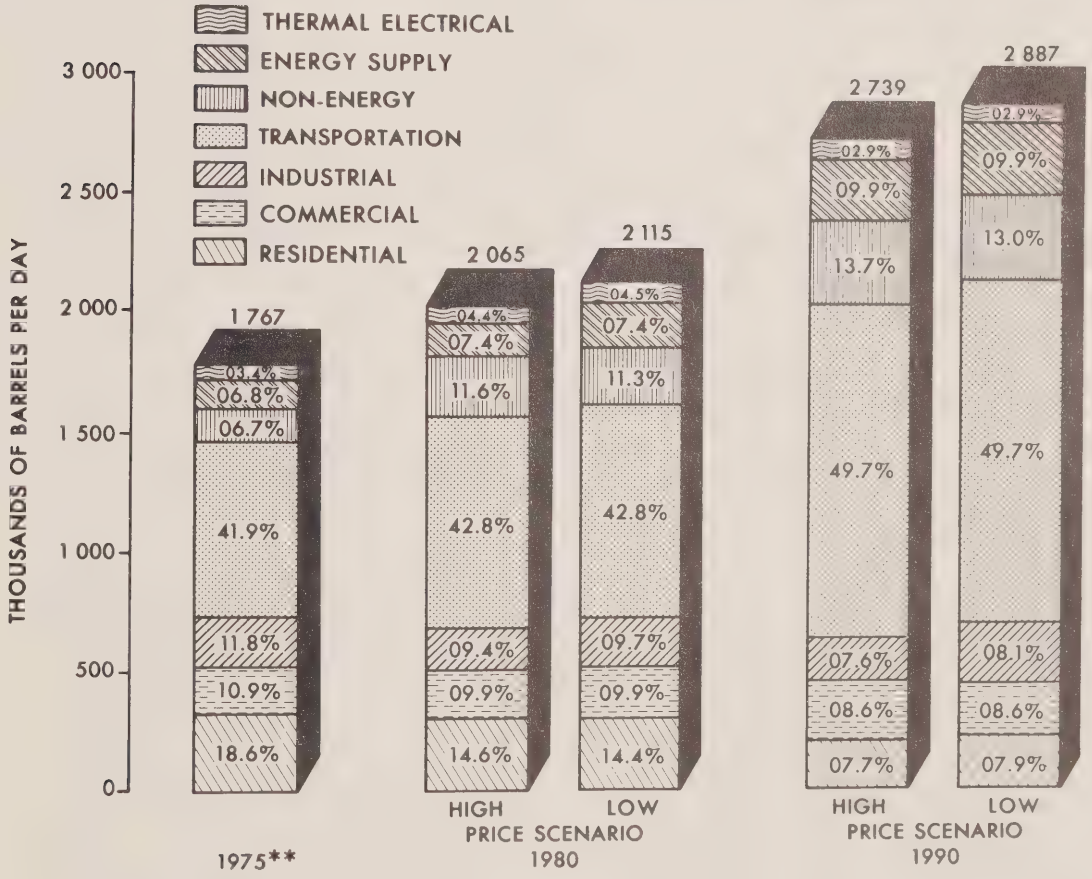
Table 4

Oil* Demand: Two Scenarios

Economic Growth:	High-Price Scenario		Low-Price Scenario	
	High	*Low*	*High*	*Low*
	(thousands of bbls/day)			
1975**	1 749	1 749	1 749	1 749
1980	2 066	2 066	2 115	2 115
1985	2 404	2 314	2 528	2 436
1990	2 889	2 588	3 043	2 731
	Average Annual Growth Rates (%)			
1976–80	3.4	3.4	3.9	3.9
1981–90	3.4	2.3	3.7	2.6
1976–90	3.4	2.6	3.8	3.0

* Including liquefied petroleum gases (LPG's).
** Estimate.

Figure 6. Demand for oil* by use: two scenarios



* Includes liquefied petroleum gases.
** Estimate.

NOTE: Transportation demand does not reflect recently announced mileage standards for automobiles (see Figure 30).

rapidly in the residential sector and to a lesser extent in commercial and industrial uses. The transportation and non-energy use sectors account for most of the increase in proportion of oil consumed.

Natural Gas

Projections of future demands for natural gas are presented in Table 5. In both scenarios it has been assumed that the price of natural gas increases to commodity-equivalent value with crude oil at the Toronto city-gate in 1978. Even after this relative price adjustment, natural gas is assumed to retain a preferred market position in relation to oil for residential use because of its clean-burning qualities. In addition, because of the higher cost of transporting natural gas, it is assumed to retain some price advantage in western Canada. For these reasons it is anticipated that the demand for natural gas will increase more rapidly than the demand for total energy and the relative share of natural gas in total energy will continue to increase, although more slowly than in the 1960's when the relative share of natural gas doubled.

Higher overall energy prices could result in a 7.5% reduction in gas demands in 1990, or about 230 billion cubic feet. This would represent a cumulative difference in natural gas demands of almost 1.8 trillion cubic feet over the period from 1976-1990.

Projections of gas demand by use are presented in Figure 7. As in the case of oil, the differences over time are more significant than those between scenarios. The residential and thermal electrical shares of gas demand fall under both scenarios, as does the industrial share to a lesser extent. The uses which absorb a larger share of gas demands are non-energy, commercial and energy supply.

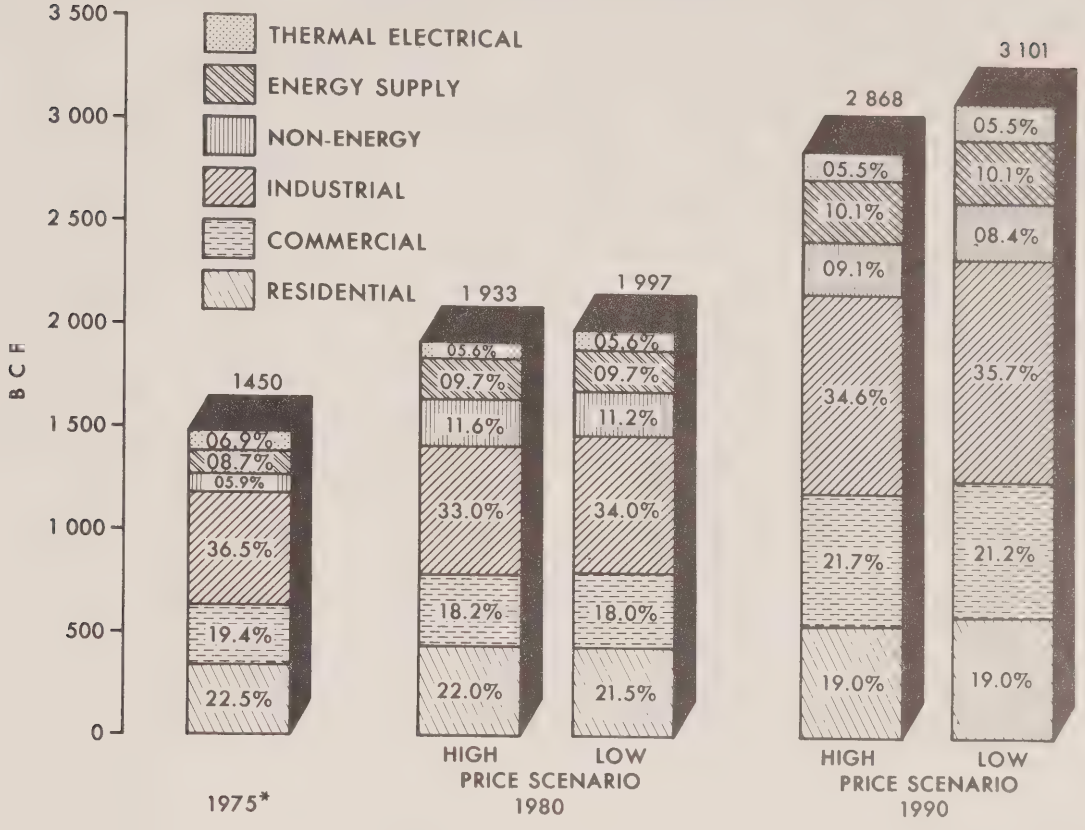
Table 5

Natural Gas Demand: Two Scenarios

	High-Price Scenario		Low-Price Scenario	
Economic Growth:	*High*	*Low*	*High*	*Low*
	(billions of cubic feet/year at 1 000 Btu/cf)			
1975*	1 450	1 450	1 450	1 450
1980	1 933	1 933	1 997	1 997
1985	2 363	2 292	2 535	2 463
1990	2 996	2 740	3 234	2 968
	Average Annual Growth Rates (%)			
1976–80	5.9	5.9	6.6	6.6
1981–90	4.5	3.5	4.9	4.0
1976–90	5.0	4.3	5.5	4.9

* Estimate.

Figure 7. Demand for natural gas by use: two scenarios



* Estimate.

The projections for oil and gas demand presented in Tables 4 and 5 differ from recent, higher, estimates prepared by the National Energy Board*. The two sets of estimates are not strictly comparable since they have been prepared using different methods and different assumptions. The EMR projections are based on a "total energy" framework related to specific assumptions with regard to demographic and economic activity, energy prices, and market shares. The NEB projections were derived from detailed analysis of the domestic oil and gas markets on the basis of submissions received at public hearings and independent analysis.

Electricity

Projected demands for electrical power are shown in Table 6. In both scenarios the demand for electricity is projected to increase more rapidly than the demand for total energy. Over the 1976-80 period, if energy prices remain at their end-1975 level in constant dollars it is anticipated that electricity demands could increase by just under 7% per year. Moving to the price structure for all energy forms assumed in the high-price scenario would reduce this expected

* *Canadian Oil Supply and Requirements*, National Energy Board, September, 1975. *Canadian Natural Gas Supply and Requirements*, National Energy Board, April, 1975.

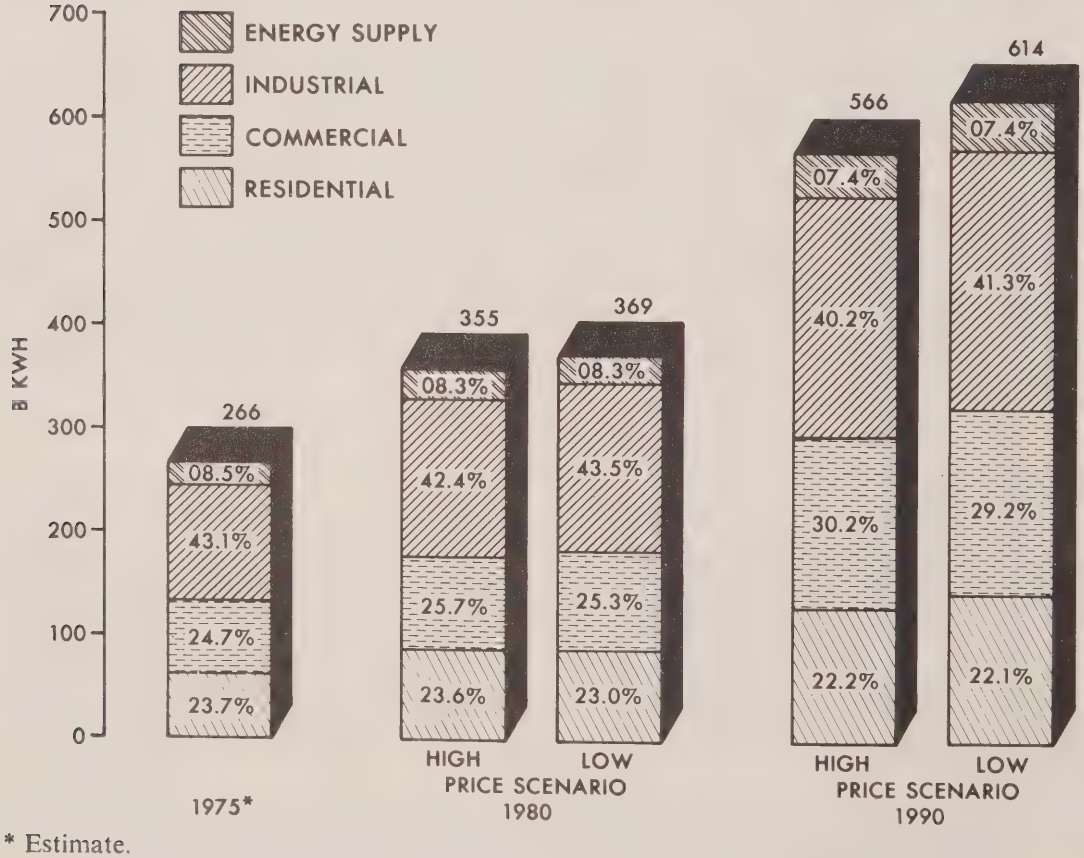
Table 6

Electricity Demand: Two Scenarios

	High-Price Scenario		Low-Price Scenario	
Economic Growth:	*High*	*Low*	*High*	*Low*
	(billions of kilowatt-hours)			
1975*	266	266	266	266
1980	355	355	369	369
1985	450	435	486	471
1990	592	538	642	586
	Average Annual Growth Rates (%)			
1976–80	5.9	5.9	6.8	6.8
1981–90	5.2	4.2	5.7	4.7
1976–90	5.5	4.8	6.0	5.4

* Estimate.

Figure 8. Demand for electricity by use: two scenarios



* Estimate.

growth rate to about 6% per year. With these higher prices, it is estimated that, over the fifteen-year period to 1990, electricity demands could increase by 4.8% to 5.5% per year, depending on the rate of economic growth. In both scenarios the relative share of total energy that is projected to be demanded in the form of electrical power increases to about 40% by 1990. To the degree that prices for electricity can be constrained from rising as rapidly in real terms as other energy prices, the competitive position of electrical power could be enhanced, at the expense of oil and natural gas.

Projections of end-use shares of total electrical consumption are presented in Figure 8. No demands are shown for the transportation, non-energy or thermal electrical sectors. The demand for electricity by the commercial sector is expected to increase relatively more quickly than total demands for electrical power.

Coal

Projections of coal demand are presented in Table 7. In the high-price scenario, under the assumption that coal prices increase along with other energy prices, the demand for coal is expected to increase from about 28 million tons in 1975 to between 59 and 66 million tons by 1990, representing annual average growth rates of 5.1% and 5.9% respectively.

In the low-price scenario coal demands are anticipated to increase at slightly less than 8% per year to 1980 and between 4.5% and 5.7% during the decade of the 1980's, depending on the assumptions about economic growth. As in the case of electricity, the actual demands that materialize will depend on the degree

Table 7

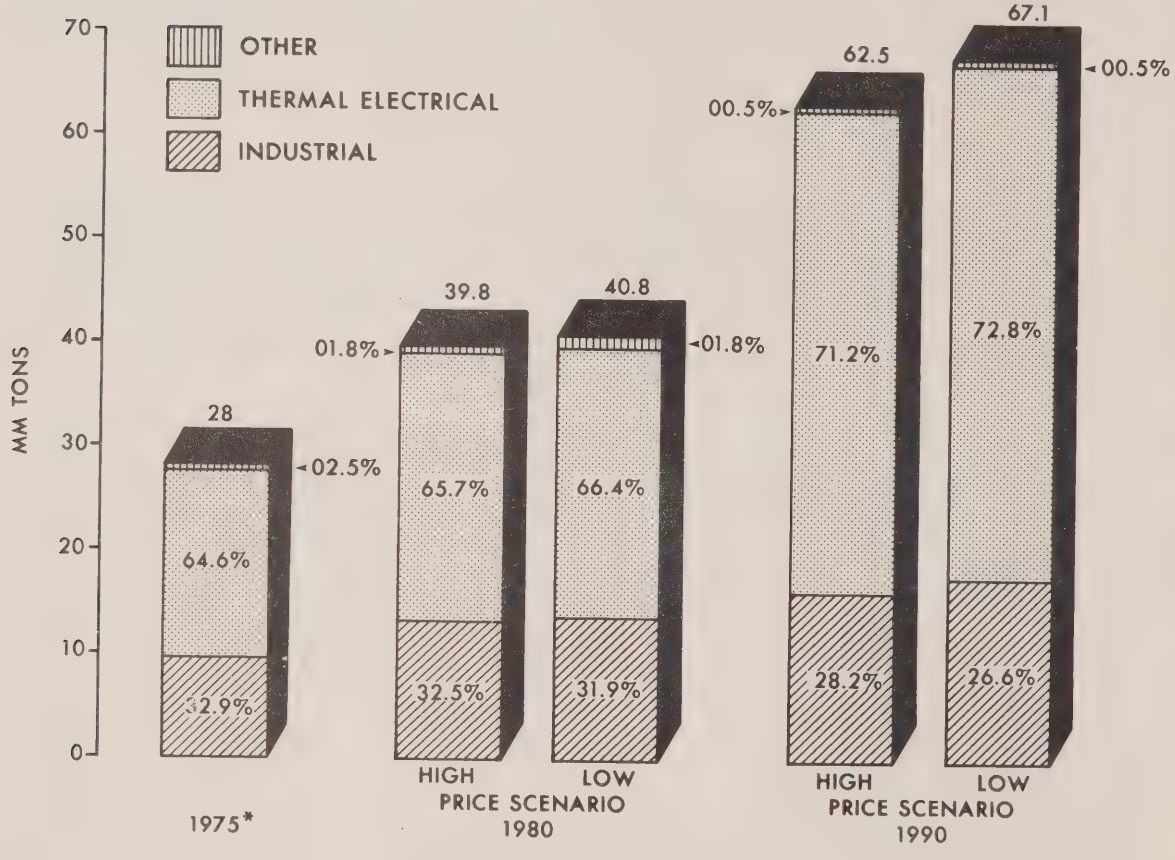
Coal Demand: Two Scenarios

	High-Price Scenario		Low-Price Scenario	
Economic Growth:	*High*	*Low*	*High*	*Low*
		(*millions of tons*)		
1975*	28.0	28.0	28.0	28.0
1980	39.8	39.8	40.8	40.8
1985	50.3	48.7	53.5	51.8
1990	66.0	58.9	70.7	63.4
		Average Annual Growth Rates (%)		
1976–80	7.3	7.3	7.8	7.8
1981–90	5.2	4.0	5.7	4.5
1976–90	5.9	5.1	6.4	5.6

* Estimate.

to which increases in the price of coal can be constrained. They will also, of course, depend on the degree to which the demand for electric power increases since the bulk of increases in the future domestic demand for coal is expected to be for electrical power generation. Projections of coal demand by end-use, presented in Figure 9, indicate that thermal electrical generation, which already accounts for nearly two thirds of total coal demands, is likely to increase its share even further. This is estimated to occur at the expense of all other end-use sectors.

Figure 9. Demand for coal by use: two scenarios



* Estimate

Chapter 3. ENERGY SUPPLIES: 1976-1990

In this chapter two possible scenarios for future Canadian energy supplies are presented. As in the energy demand analysis, the scenarios are distinguished essentially by the assumptions that have been made with regard to energy prices. The price assumptions used to generate the supply projections presented below are consistent with those used to generate the corresponding demand projections. The resulting supply/demand balances, for total energy and for each energy commodity, are presented and discussed in Chapter 4.

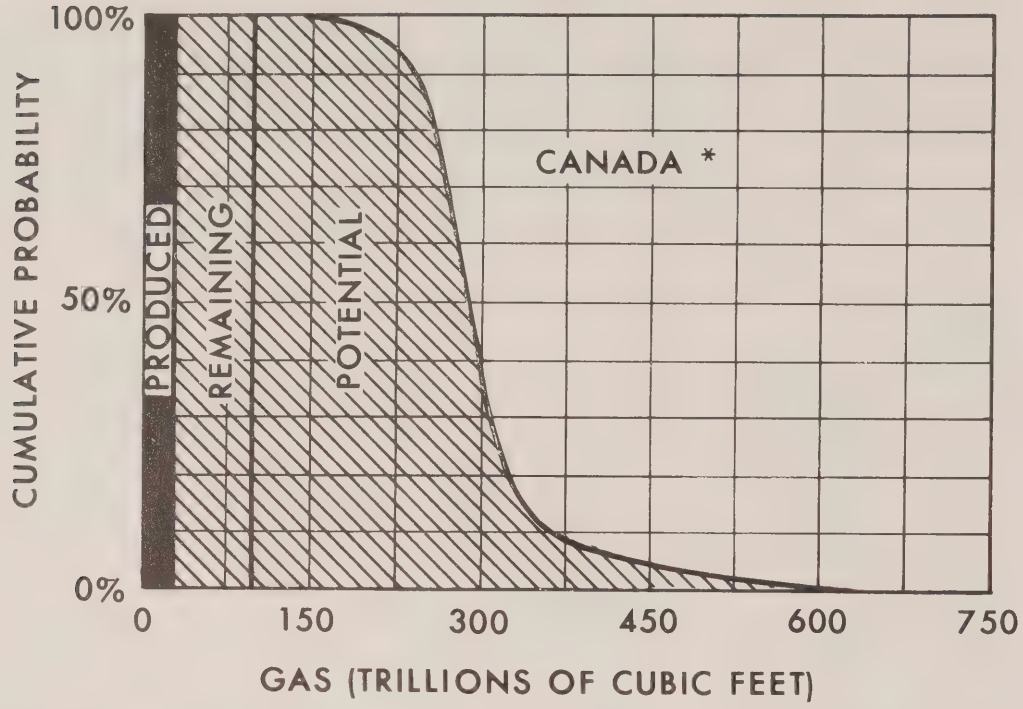
In general, the procedures adopted for estimating future supplies are different in approach to oil and natural gas than to electricity and coal. In the former case, it has been assumed that current fiscal systems remain intact and that no major technological advances will occur over the period 1976-90. In this context detailed analysis, based initially on geological information as to the magnitude and location of prospective oil and natural gas resources, is continuing in order to assess what resources might be found, commercially developed and delivered, and over what time period, at the assumed price levels. It must be emphasized that the supply estimates—and, in particular, the development of resources that are as yet undiscovered—depend only on assumptions with respect to geology, technology and profitability. They represent an assessment of future supplies that has not specifically examined environmental considerations, native land claims, provincial development policies, shortages of skilled manpower or equipment at 1975 prices, or transportation systems, and could therefore prove to be optimistic, particularly with regard to the timing of frontier resources.

With regard to the projection of electricity supplies, an alternative procedure has been employed. The expansion of electrical systems is primarily determined by considerations of meeting anticipated regional market demands, with acceptable reserve margins, in the most efficient manner possible. An electricity supply projection must therefore be based principally on a projection of future demand growth. Conceptually, electricity supply and demand should balance at a given price. This point is discussed further in connection with the electricity projections presented below.

Estimates of the Potential Resource Base

The forecasts of oil and natural gas supplies begin from assumptions about the magnitude and distribution of the potential resource base. These assumptions reflect the difficulties of estimating the amount of the resource which may eventually be found. It is difficult enough to determine figures for reserves (i.e. proved resources), but estimating the undiscovered resource potential is much more hazardous. In this respect, the Geological Survey of Canada has under

Figure 10. Cumulative frequency distribution of ultimate recoverable natural gas resources of Canada



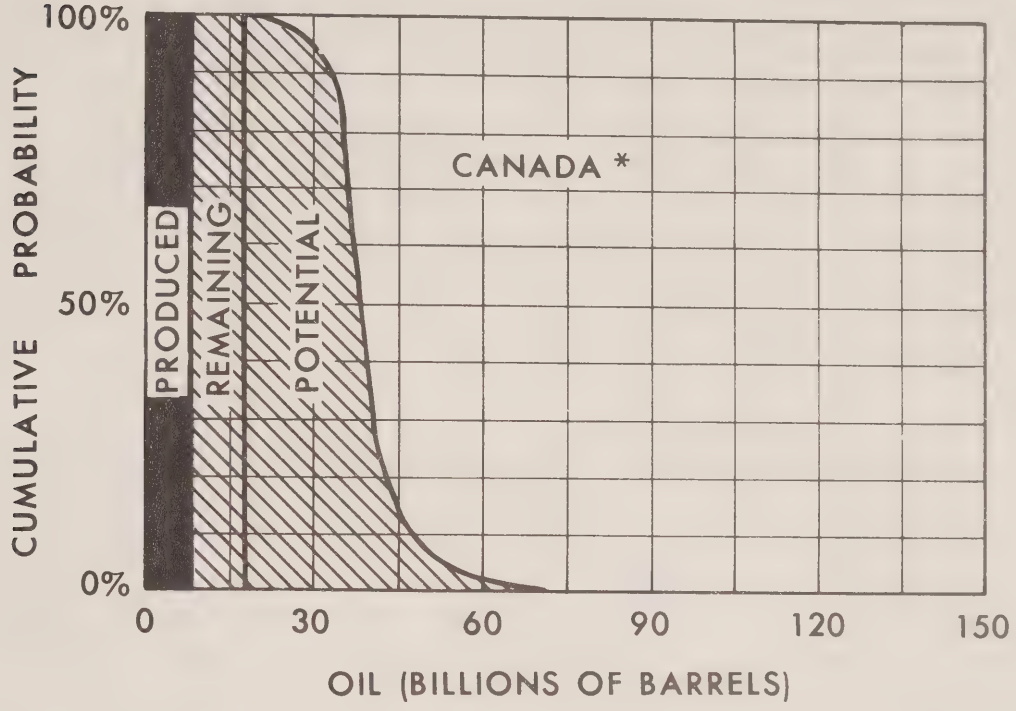
PROBABILITY	100	90	80	70	60	50	40	30	20	10	5	0
ULTIMATE	100	237	251	262	272	282	294	309	328	363	400	681

* Excludes offshore inaccessible areas for which the depth of water is beyond current drilling capabilities, under permanent ice or by environmental restraint not currently available for exploratory drilling.

development a new methodology, based on statistical probabilities. This methodological approach will be discussed in a technical study to be published in the near future.

This new method of estimating petroleum resources attempts to overcome the problem arising from the use of a single set of numbers to estimate the extent of the resource base, an approach which has proved unsatisfactory because it fails to indicate the level of probability attached to the estimates. Neither does it distinguish between the resource potential, as yet undiscovered, and the proved reserve on which supply estimates can be based. The current method of analysis, in contrast, seeks to indicate the *degree of probability*, as is illustrated by Figures 10 and 11, which show recent estimates of Canada's natural gas and oil resources excluding inaccessible offshore areas. Figure 10 suggests, for example, that there is an 80% probability that at least 251 Tcf of natural gas exist in Canada; there is a 30% probability that at least 309 Tcf of gas exist;

Figure 11. Cumulative frequency distribution of ultimate recoverable oil resources of Canada



PROBABILITY	100	90	80	70	60	50	40	30	20	10	5	0
ULTIMATE	17.3	33.1	34.7	35.9	37.0	38.0	39.3	40.8	42.8	46.9	51.9	80.3

* Excludes offshore inaccessible areas for which the depth of water is beyond current drilling capabilities, under permanent ice or by environmental restraint not currently available for exploratory drilling.

and a zero probability that gas resources will exceed 681 Tcf. Similarly for oil, Figure 11 shows that the proved reserve (100% probability) is 17.3 billion barrels, of which approximately half has already been produced, and that there is a 50% probability that at least 38 billion barrels of oil exist. This approach sets in perspective some of the past estimates of the extent of Canada's oil and natural gas resources, and illustrates how different figures, which may seem contradictory, rather reflect different levels of certainty, of optimism or of caution.

It is important to note that these estimates are prepared on the basis of physical resource potential only; they specifically do not include the consideration of economics. Indeed, the volumes of oil and gas which might be economically recoverable at foreseeable prices may be only a fraction of the physical resource potential. A detailed analysis of the economics of Canada's oil and gas resource base will be the subject of a technical paper to be published later this year.

In 1973, the Geological Survey of Canada reported that the most probable estimate of ultimate recoverable oil was 99.2 billion barrels and of ultimate recoverable natural gas 782.9 Tcf. There are three main reasons why the Survey's current estimates are much lower. First, the 1973 figures were based on a less sophisticated method using a geological analysis of all the sedimentary basins in Canada and comparing these with other petroleum-producing basins throughout the world. Second, significantly more information is now available from exploratory drilling, and it must be recalled that over the past two years drilling results in the frontier area have been very disappointing. Finally, these estimates are not strictly comparable because the areas included are not the same: the 1973 estimates included for example, the continental slope and rise, whereas the latest estimates do not.

Oil

The oil supply projections are summarized in Table 8. Estimates of regulated production levels of crude oil and equivalent from established areas are consistent with the September 1975 report of the National Energy Board*. The Board's forecast of producibility from established areas was based on a detailed assessment of 163 pools accounting for 88% of the total established reserves in Canada. This assessment assumed that prevailing prices would be adequate to bring the technically-based deliverable volumes on stream. For this reason, the estimated production of crude oil and equivalent from established areas is identical in the high-price and low-price scenarios. In commenting on its estimate of producibility from reserve additions the Board noted that "a very substantial increase in the price of crude oil or a major technological breakthrough in tertiary recovery techniques could make this forecast conservative."** The extent to which higher crude oil prices will result in increased recovery of oil from known reservoirs requires further investigation, and the possibility exists that the estimates of potential supply from established areas in the high-price scenario may be too low. The supply estimates shown in Table 8, for established areas, include, as well as crude oil and equivalent, estimated gas-plant production of Liquefied Petroleum Gases (LPG's).

There is currently a considerable amount of uncertainty with respect to the rate at which developments will take place in the oil sands, largely attributable to the recently observed cost escalation in the Syncrude project and to some remaining doubts as to the practicability of the yet unproved Syncrude technology. It is clear that, barring major technological advances, future oil sands plants would appear to be only marginally attractive at current international oil prices, even with the special fiscal concessions that have been made in the case of the Syncrude project. In the high-price scenario it has been assumed that one additional mining project will begin production in 1982, with a capacity output of 110 000 bbls/day being reached by 1986. In addition, another plant,

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* *Canadian Oil Supply and Requirements*, National Energy Board, September, 1975.

** *Ibid.*, p. 26.

Table 8

Possible Oil* Supply

(thousands of barrels per day)

	High-Price Scenario			
	*1975***	*1980*	*1985*	*1990*
Established areas	1 737	1 472	1 136	736
Oil sands	43	153	274	444
Frontier areas	—	—	—	500
Total	1 780	1 625	1 410	1 680

	Low-Price Scenario			
	*1975***	*1980*	*1985*	*1990*
Established areas	1 737	1 472	1 121	722
Oil sands	43	153	189	194
Frontier areas	—	—	—	—
Total	1 780	1 625	1 310	916

* *Established areas* supply includes an estimate of gas-plant LPG's.

** Estimate.

which could be either a mining or in situ recovery operation, is envisaged to begin production in 1986 and reach an output of 140 000 bbls/day by 1990. In the low-price scenario, no oil sands developments additional to those already underway are foreseen over the next fifteen years.

The potential to develop new oil reserves in the frontier areas of Canada remains a major question mark at the moment. Reserves proved to date are virtually insignificant compared with the reserves of about 3-4 billion barrels that would be necessary to support a 500 000 barrel/day pipeline for twenty years. Nevertheless, in submissions to the National Energy Board during 1975, three companies forecast that production from the Mackenzie Delta-Beaufort Sea area would begin in 1983-84. In recent months, Panarctic has made a promising discovery at Bent Horn on Cameron Island in the eastern Arctic. It is still too early, however, to estimate the magnitude and commercial viability of possible production from this area.

It has been assumed in the high-price scenario that frontier oil reserves will be discovered and will begin flowing to markets in 1986, at a rate of 250 000 bbls/day, increasing to 500 000 bbls/day by 1990. This schedule would allow some 6-7 years for sufficient oil to be found to justify a delivery system and 3-4 years for such a delivery system to be put in place. These assumptions

would appear to be reasonable if frontier exploration continues at an active pace and if a fair proportion of future discoveries turn out to be oil rather than gas. In view of the high costs of exploration and development work in the Arctic and offshore areas, and the expensive delivery systems required, it seems certain that no frontier oil would be developed under the low-price scenario.

Natural Gas

Projected natural gas deliverability is presented in Table 9. The estimates of deliverability from established areas were developed within the Department of Energy, Mines and Resources. The analytical framework used to produce these estimates is similar to that used by the National Energy Board, in the preparation of its recent report on natural gas*. Differences between the Table 9 projections for established areas and the NEB estimates are attributable to differing basic assumptions; this analysis has followed a "scenario approach" whereas the NEB assumed "adequate incentives". Supply forecasts will differ because of differing field-price assumptions and, over time, as a result of differing demands for gas consistent with alternative assumptions about gas prices. For example, the deliverability figure indicated in the high-price scenario (2 976 Bcf) for 1980 is lower than the deliverability under the lower price assumption as a result of lower estimated demands in the high-price scenario.

The magnitude and timing of deliverability of natural gas from the frontier regions remain unclear at the moment. The proposals for a Mackenzie Valley pipeline currently being heard by the National Energy Board envisage a start-up date of 1982. In line with these applications, a corresponding assumption has been made for the development of the supply scenarios presented here. For the high-price scenario, it has been assumed that natural gas from the Arctic Islands begins flowing in 1985. It is estimated that frontier gas deliveries will begin at annual rates of about 275 Bcf in 1982, increasing to 1.04 Tcf by 1985 and 2.10 Tcf by 1990. Again, it must be emphasized that these estimates reflect expectations of what can be technically and economically delivered on the basis of current geological information. They are not constrained by environmental or social considerations, the availability of labour or capital equipment or the absence of markets. Finally, it should be noted that economic analysis indicates that no frontier gas supplies would be forthcoming in the low-price scenario.

Off the east coast of Canada, it is expected that natural gas from the Sable Island area and possibly the North Sydney basin may prove to be economic before 1990. The transportation economics appear relatively favourable and deliveries as indicated in Table 9 could occur, even in the low-price scenario.

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* *Canadian Natural Gas Supply and Requirements*, National Energy Board, April 1975. The Board's estimates of deliverability were 3 043 billion cubic feet in 1980 and 2 927 Bcf in 1985 (Table 22).

Table 9

Possible Natural Gas Deliverability

(billions of cubic feet per year at 1000 Btu/cubic foot)

	High-Price Scenario			
	*1975**	*1980*	*1985*	*1990*
Established areas	2 521	2 976	3 126	2 363
Mackenzie Delta / Arctic Islands	—	—	1 040	2 099
East coast	—	—	55	91
Total	2 521	2 976	4 221	4 553

	Low-Price Scenario			
	*1975**	*1980*	*1985*	*1990*
Established areas	2 521	3 011	2 821	2 055
Mackenzie Delta / Arctic Islands	—	—	—	—
East coast	—	—	55	91
Total	2 521	3 011	2 876	2 146

* Estimate.

The Grand Banks area has been very disappointing to date and no economic hydrocarbon production is projected by 1990. Prospects are much more favourable on the Labrador Shelf with three or four significant discoveries. Because of water depths, marauding icebergs, pack-ice, short window periods and relative inaccessibility, however, it appears unlikely that technology will be available for development in this area before the 1990's. Costs will be extremely high and discoveries will have to be highly productive to be commercially viable.

Electricity

As noted above, the configuration of electrical systems and the resulting supplies through time depend principally on expected demand projections. The ultimate economic constraint on expanding electrical capacity arises from the price of electricity relative to the prices of other energy forms that can be substituted for it.

The demand for electricity, and hence the resulting supplies, will depend on such factors as income, population, the availability and price of substitute fuels, capital costs of energy-using equipment, technology, convenience factors, and, of course, the price of electricity. This, in turn, will be affected by capital

requirements for capacity expansion, financial characteristics of the utility concerned, and decisions of regulatory agencies. All of these factors interact in complex ways and, to reflect a reasonable range of future electrical supply potential, two projections of installed electrical capacity are presented in Table 10.

The high-growth case suggests that total electrical generation capacity would increase from almost 60 000 megawatts (MW) in 1975 to about 152 000 MW by 1990. Such expansion would be designed to meet Canadian demands for electricity that continue to increase at an average growth rate of about 7% per year, and corresponds to utilities' expansion plans as determined by a survey of electrical utilities conducted by EMR in late 1975. The additions would most likely consist of nearly 40% in hydroelectric capacity or about 35 000 MW, principally in British Columbia (11 000 MW), Manitoba (4 500 MW) and Quebec (17 000 MW). Conventional thermal generation using coal or oil would add 29 000 MW or 31% of the total, including British Columbia (4 000 MW), Alberta (5 000 MW), and Ontario (12 000 MW) as well as substantial additions in Saskatchewan, Quebec and the Maritime provinces. The third segment is nuclear capacity located in Ontario (19 300 MW), Quebec (5 100 MW) and the Maritimes (2 400 MW) for a total of nearly 27 000 MW or 29%.

Table 10

Projection of Installed Electrical Capacity

(*Megawatts*)

	High-Growth Case			
	Hydro	*Nuclear*	*Other***	*Total*
1975*	36 800	2 660	20 080	59 540
1980	46 700	6 900	25 400	79 100
1985	61 900	17 800	31 400	111 100
1990	72 500	29 500	49 800	151 800
	Low-Growth Case			
	Hydro	*Nuclear*	*Other***	*Total*
1975*	36 800	2 660	20 080	59 540
1980	42 500	6 200	23 700	72 400
1985	55 500	12 800	29 500	97 800
1990	66 200	22 200	36 800	125 200

NOTE: The high-growth case reflects the expansion plans of provincial utilities as of end-1975. The recent announcements of delays in capacity expansion programs are not reflected. The low-growth case has been generated within Energy, Mines and Resources and represents a capacity expansion program to meet load growths that increase on average by 5.5% per year from 1976-1990. Electrical energy availability corresponding to these capacity estimates are presented in Tables 12 and 13 in Chapter 4.

* Estimate.

** Other generation includes electrical power generated from coal, oil and natural gas.

The low-growth case has been developed within EMR to reflect the reduction of future rates of demand growth for electrical power that were noted in Chapter 2. This capacity expansion program would involve the construction of about 65 000 MW of additional capacity between 1975 and 1990, about 25 000 MW less than the high-growth case. It would allow the continued satisfaction of electricity demands that increased, on average, by about 5.5% per year, reaching a level of about 600 billion kilowatt-hours in 1990. The nuclear component would grow less rapidly in this scenario, increasing by less than 20 000 MW and accounting for about 17.7% of total electrical capacity by 1990. The low-growth case presented in Table 10 corresponds fairly closely to a demand projection for electricity that is close to the upper end of the range in the high-price scenario.

There are two major reasons why it is appropriate to develop the electricity supply scenarios in this manner. First, the demand estimates for total energy are uncertain, as was noted above. They depend critically on assumptions which must be regarded as preliminary and tentative, about economic and demographic events that will take place in the 1980's. Even in this context there is considerable uncertainty over the rate at which electrical power can continue to penetrate the energy market. It appears clear that the proportion of our energy requirements that will be met by electricity will continue to increase, but the rate of that increase will depend on a number of factors that are not easily determined, such as future price relationships among competing fuels, and consumer decisions based on views about convenience and relative availabilities. In this connection it would appear prudent, to some degree, to base capacity expansion plans, at least initially, on projected load growths that are closer to the upper end of the plausible range. Costs incurred in the earlier years of a large project requiring several years lead time tend to be relatively small and, should it become apparent that future load growth is occurring less rapidly than anticipated, construction timetables can be deferred or projects cancelled at relatively low cost. It is more difficult and costly to accelerate production if demands increase more rapidly than anticipated.

Second, both of the capacity expansion plans presented here are feasible on the basis of currently available technology. It is questionable whether, with the expected increase in relative energy prices, electricity demand will continue to grow at 7% per year through the next fifteen years. If it did, the relative share of electricity in total primary energy consumption would increase from about 33% in 1975 to between 47 and 50% by 1990. This does not mean, however, that electrical demand cannot continue to grow at historically observed rates, and in this sense, the difference between the demand projections underlying the two capacity expansion plans presented here and the demand projections discussed in the previous chapter represent one measure of the degree to which electricity might be substituted for other energy sources.

Future electrical expansion will require large amounts of capital, skilled labour and equipment. It is estimated that the capacity expansion program discussed in the high-growth case would require, over the next fifteen years, about

$130 billion worth of labour and materials, purchased at 1975 prices. In relation to the expected size of the economy that would have to supply these requirements, these demands would be roughly equivalent to the demands of the total energy sector over the past fifteen years. The difference in estimated capital requirements between the high-growth and low-growth cases would amount to $40 billion, or an average of more than $2.5 billion per year, in 1975 dollars. Anticipated capital requirements of this magnitude do not imply that expansion envisaged cannot be successfully completed. They do suggest, however, that projects will have to be carefully coordinated in a manner that minimizes inflationary pressures and avoids bottlenecks in the supply of materials and manpower. Further, they raise the critical question, which must be pursued further in cooperation with provincial utilities, of the degree to which electricity can maintain a competitive advantage relative to alternative energy sources. These issues are discussed further in the next chapter.

Coal

The coal picture has changed dramatically in Canada over the past five years. After a period of severe decline in the 1950's and 1960's, largely as a result of the conversion of the railways to diesel fuel, the coal industry in Canada is enjoying a period of expansion. Both the costs of extracting coal and the selling price of coal have escalated rapidly in recent years, and future supply trends for coal will be influenced by the relative rates at which prices and costs increase. The current analysis presents a possible supply projection for the various types of coal, where the supply estimates represent the capacity of the coal industry to meet potential demands. This projection has been prepared in a manner similar to those for electricity, in order to highlight the potential that exists for interfuel substitution. The estimated supplies are shown in Table 11.

Table 11

Possible Coal Supply

(*millions of tons*)

	*1975**	*1980*	*1985*	*1990*
Low rank thermal	10.4	19.4	39.9	74.3
High rank thermal	2.3	4.2	6.0	7.2
Metallurgical	15.0	21.3	34.6	36.6
Total	27.7	44.9	80.5	118.1

* Estimate.

Total coal production in 1975 amounted to about 28 million tons. The projections in Table 11 imply very rapid rates of increase in Canadian coal production, with almost a tripling of current production rates over the next ten years. Current production of metallurgical coal is about 15 million tons of which 13.5 million tons are committed under long-term export contracts. The metallurgical coal figures shown for 1980, 1985, and 1990 represent estimated total levels of production available to meet domestic and export demands. The projected thermal coal supplies are based on the expansion plans of provincial electrical utilities.

These supply estimates obviously depend on the favourable resolution of a number of issues, and should be qualified accordingly. With the recent rapid price increases for all types of coal, and concern about the depletion of oil and gas reserves, a policy of restraint with regard to future coal development has been adopted in the western producing provinces. In addition to this reevaluation of the role of coal in provincial economies, there has been a reassessment of the environmental impact of coal operations, on the part of the Governments of British Columbia and Alberta, in order to define clearly the areas in which mining may be permitted and the conditions under which it should be authorized. In September of 1974, after more than two years of public hearings, the Environmental Conservation Authority of Alberta issued a report on land use and resource development in the eastern slopes of the Rocky Mountains. This report is currently under consideration by the Government of Alberta and no final approvals have been granted for coal development, even though some projects have received approval from the Energy Resources Conservation Board. Royalty rates are also under review in the producing provinces. Royalties have been increased from 25¢ to $1.50 per saleable ton of coal in British Columbia. In Alberta and Saskatchewan the present royalty rates are 10¢ and 5¢ per ton respectively and increases appear certain.

This period of reassessment has effectively resulted in a moratorium on all new private bituminous coal developments during the last two years, although extensive exploratory and development drilling programs have been carried out by B.C. Hydro, Calgary Power and the Saskatchewan Power Commission. Announcements of new coal policies are expected from the Government of Alberta in the near future and from the Government of British Columbia before the end of 1976.

The economics of large-scale commercial coal gasification and liquefaction plants have not yet been clearly defined, and the potential to introduce large scale (250 Mcf/day) synthetic natural gas plants in Canada appears to be limited by the small number of economically mineable coal deposits large enough to support operations on this scale. The economic viability of conversion processes is currently being studied for synthetic natural gas supplies and for combined cycle generation of electricity or alternative clean fuel supplies.

Most electric utilities are constituted as provincial crown corporations, and they have the advantage of access to relatively favourable financing as well as other types of government support. These considerations could allow provincial governments some flexibility in assessing royalties on coal used for generation of electricity and as a feedstock for coal conversion processes, in mining taxation and in pricing of the final electricity or synthetic product. These factors could have an important bearing on the scale of coal expansion over the next fifteen years.

Hydraulic mining in Michel Colliery, British Columbia.

Chapter 4.
SUPPLY/DEMAND BALANCES

In Chapter 2, a number of possible projections were presented for total energy demands and demands for particular energy commodities. Chapter 3 dealt with possible energy production that could become available under comparable assumptions. In this chapter, demands are assessed in relation to domestic availability. Supply/demand balances—which portray the domestic availability of energy in relation to domestic demands—are compared under the pricing assumptions characterizing the two scenarios developed. The implications of some of the energy problems Canada may face over the next fifteen years are discussed and the potential for alleviating prospective energy problems is examined.

To simplify the supply/demand comparisons, the four profiles for future energy demands have been reduced to two. For both the high-price scenario and the low-price scenario, the projections of future demands presented in this chapter have been calculated as the mid-point of the high and low economic growth cases presented in Chapter 2. They therefore reflect an assumed rate of economic and demographic growth that lies between the average experience of the 1960's and the lower future rates of growth presented in Table 2. They reflect an economy in which the average annual growth rate of real GNP through the 1980's would be on the order of 4.5%.

Similarly, adjustments have been made to the estimates of Canadian supplies presented in Chapter 3 so that they reflect more accurately domestic availability. Domestic availability is the energy available to Canadians assuming that long-term trade commitments are honoured. It is total production less exports committed by long-term contracts plus imports that are currently purchased under long-term contractual arrangements. The major adjustments occur with respect to natural gas exports and coal where both export and import contracts exist.

Low-Price Scenario

It was assumed in the low-price scenario that domestic energy prices would remain at their end-1975 level in real terms and further increases would reflect only the general rate of inflation. A summary of the estimated supply/demand position is presented in Table 12, and Figures 12–18 indicate the year-by-year positions for total energy, and the four major energy sources.

With regard to electricity, the projected demands from the low-price scenario are compared with the "high-growth" electricity supply projection, which reflects a recent survey of utilities' expansion plans and is intended to meet an anticipated load-growth of about 7% per year. Under this set of assumptions, electricity demands and supplies balance through the early 1980's, but excess capacity begins to build up in the mid to late 1980's, as the rate of

Table 12

Domestic Demand and Domestic Availability

(Low-Price Scenario)

	*1975**	*1980*	*1985*	*1990*
Oil (thousands bbls/day)				
Availability	1 780	1 625	1 310	916
Demand	1 749	2 115	2 482	2 887
Surplus (shortfall)	31	(490)	(1 172)	(1 971)
Natural gas (Bcf/yr)				
Availability	1 401	1 831	1 773	1 709
Demand	1 450	1 997	2 499	3 101
Surplus (shortfall)	(49)	(166)	(726)	(1 392)
Electricity (billions of kilowatt-hours)				
Availability	270	377	530	737
Demand	266	369	479	614
Surplus (shortfall)	4	8	51	123
Coal (millions tons)				
Availability	29.7	44.3	71.7	111.9
Demand	28.0	40.8	52.6	67.1
Surplus (shortfall)	1.7	3.5	19.1	44.8
Total energy (Btu $\times$ 10^{12})				
Availability	7 890	8 995	9 998	11 495
Demand	7 867	10 099	12 433	15 190
Surplus (shortfall)	23	(1 104)	(2 435)	(3 695)

NOTES:

1. Availability of oil figures represent crude oil and equivalent including gas plant LPG's. Although Canadian net imports of crude oil averaged 137 000 barrels/day in 1975, this was more than offset by net exports of products of more than 150 000 barrels/day.
2. Availability of natural gas excludes contractual export commitments; the shortfall shown for 1975 reflects an inability to meet current export commitments because of deliverability problems in particular fields.

* Estimate.

growth of demand declines in response to lower rates of increase in economic activity. By 1990, it is estimated that capacity expansion plans based on an annual growth rate of 7% could result in the capability to supply an additional 120 billion kilowatt-hours or about 20% of the projected 1990 demand for electric power. In practice, of course, excess electrical capacity on this scale would not exist since utilities would cut back on their expansion plans if it became apparent that anticipated rates of demand increase were not materializing. The difference between supply capability and projected demand in this scenario, indicated graphically in Figure 17, does provide an estimate of the potential which could exist to substitute electricity for other energy sources. Again, in practice, the degree to which such substitution can and will take place will depend on, among other factors, technological possibilities and the electrical generation and marketing policies adopted by utilities and provincial governments.

Similarly, in considering future supply/demand relationships for coal, it is estimated that by 1990, with favourable conditions for future coal development, Canada could be in a position where domestic availability would exceed anticipated domestic demands by almost 45 million tons (Figure 18).

Figure 12. Domestic demand and availability: total energy (1970-1990; low-price scenario)

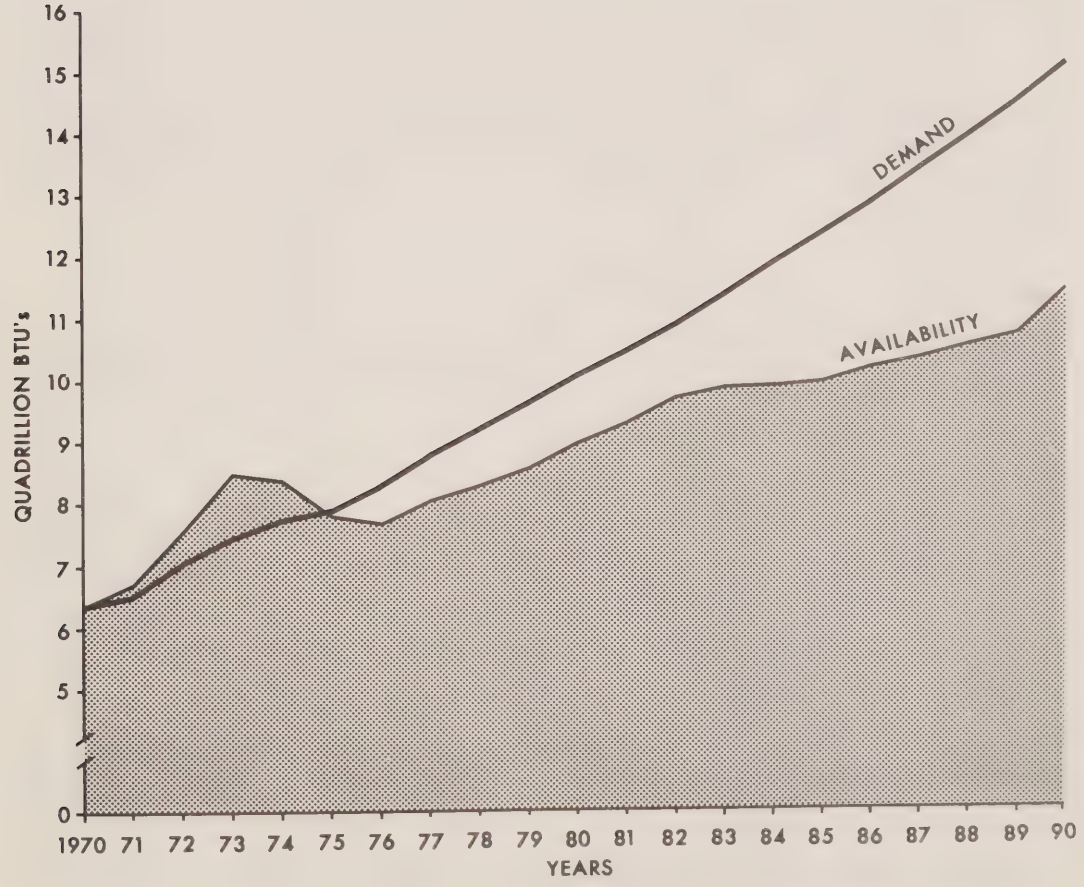
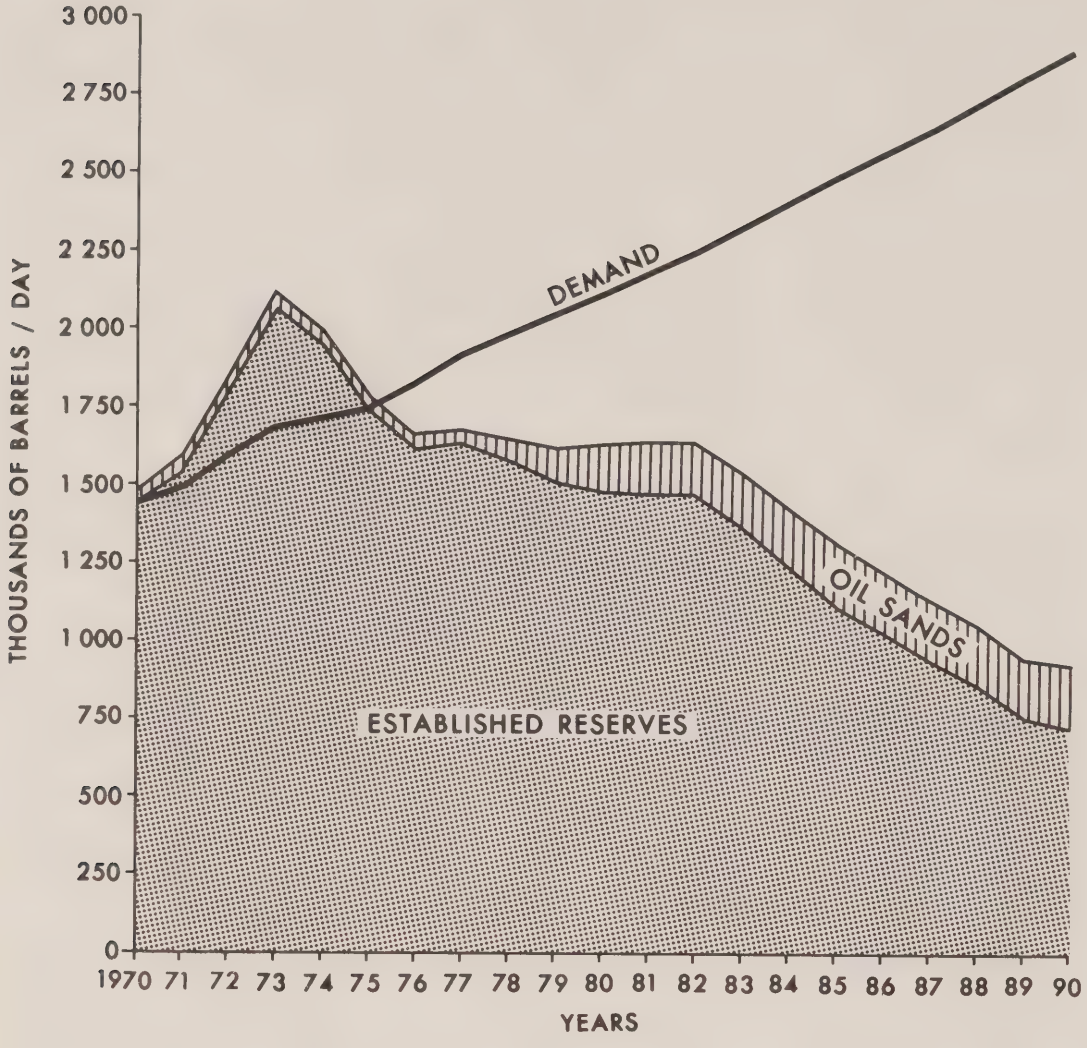


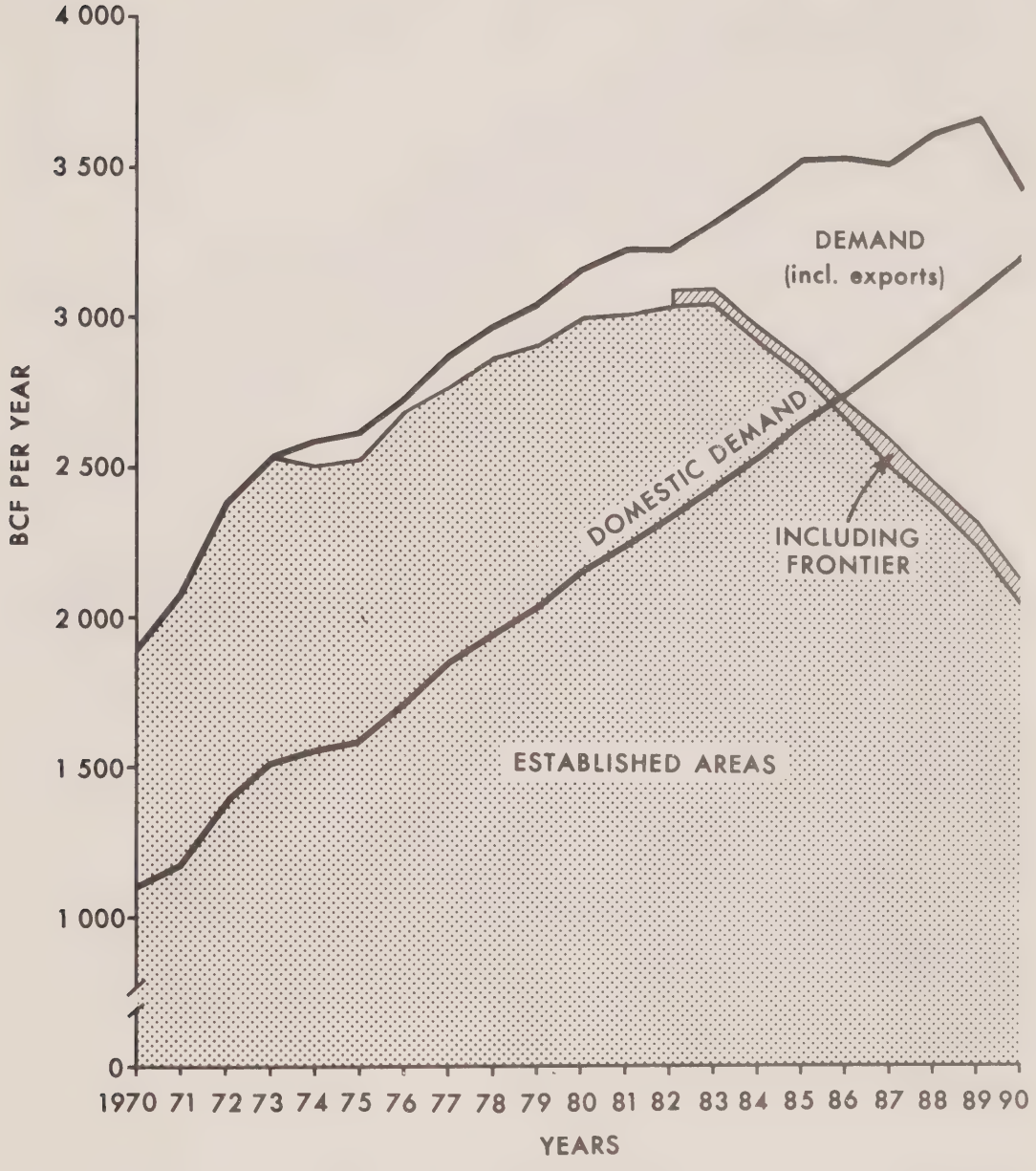
Figure 13. Domestic demand and availability: oil (1970-1990; low-price scenario)



The projected supply/demand balances for oil and natural gas, however, are much more pessimistic. Under the assumptions of the low-price scenario, demand for these energy commodities would increase more rapidly and possible future supplies from the Athabasca oil sands and from Canada's frontier areas would not become available. As indicated in Figure 13, net imports of oil could increase continuously over the next fifteen years, amounting to almost 0.5 million bbls/day in 1980, 1.2 million bbls/day in 1985 and just under 2 million bbls/day in 1990. Net oil imports, as a percentage of estimated Canadian oil demands, could approach 47% in 1985 and 68% by 1990.

Figure 14 indicates that total natural gas demands (including contractual export commitments) exceeded deliverability in 1974 and are expected to continue to do so, under the low-price assumptions, through the entire period. Although a supply shortfall existed in 1974 and 1975, this resulted from specific

Figure 14. Demand and availability: natural gas (1970-1990; low-price scenario)



production problems in British Columbia and was reflected in reduced exports of natural gas from that province to the United States. Figures 15 and 16 indicate that the current deficit on the Westcoast Transmission system is anticipated to increase through the period, whereas it appears that the demand projected for the TransCanada PipeLines system can be satisfied until the early 1980's. The degree to which the total shortfalls in deliverability indicated in Table 12 result in unsatisfied domestic demands will depend upon the process by which available supplies are allocated between domestic and export markets.

Figure 15. Natural gas demand and availability: Westcoast Transmission system (low-price scenario)

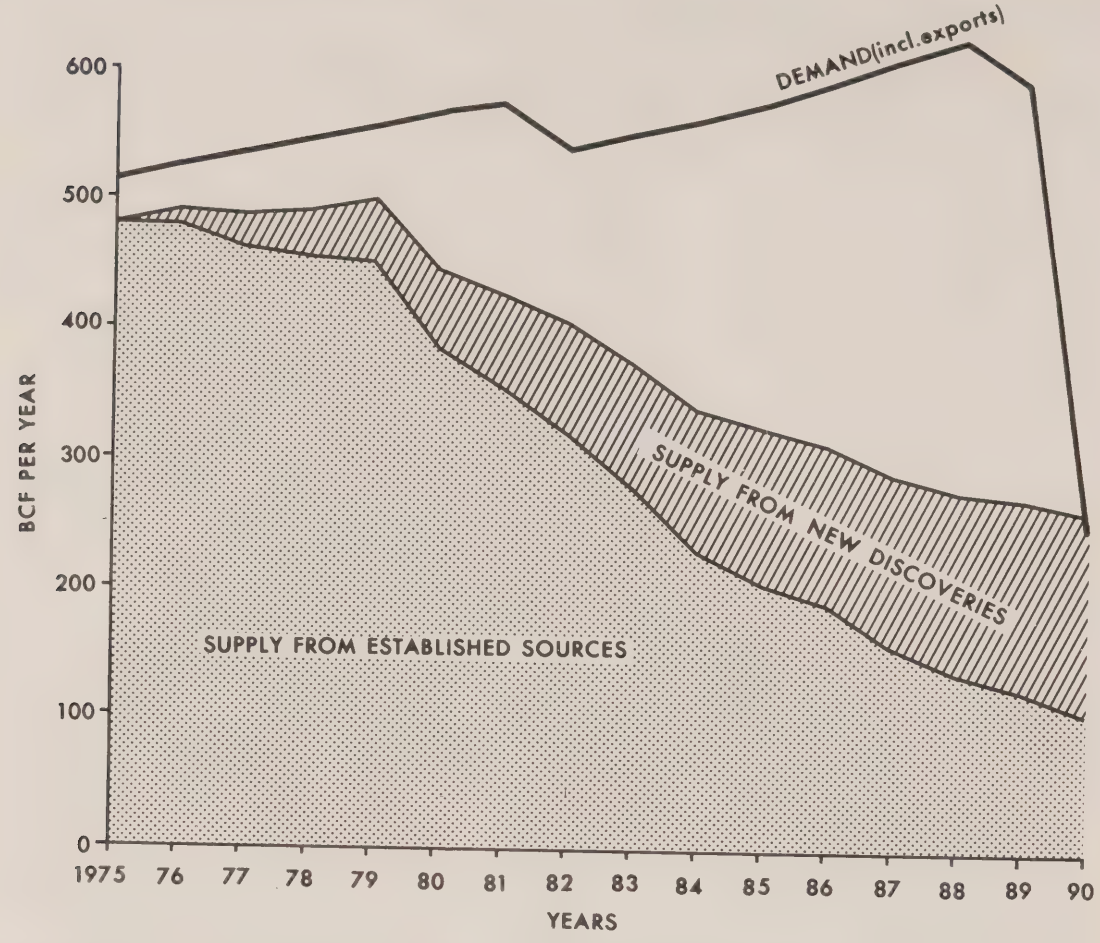
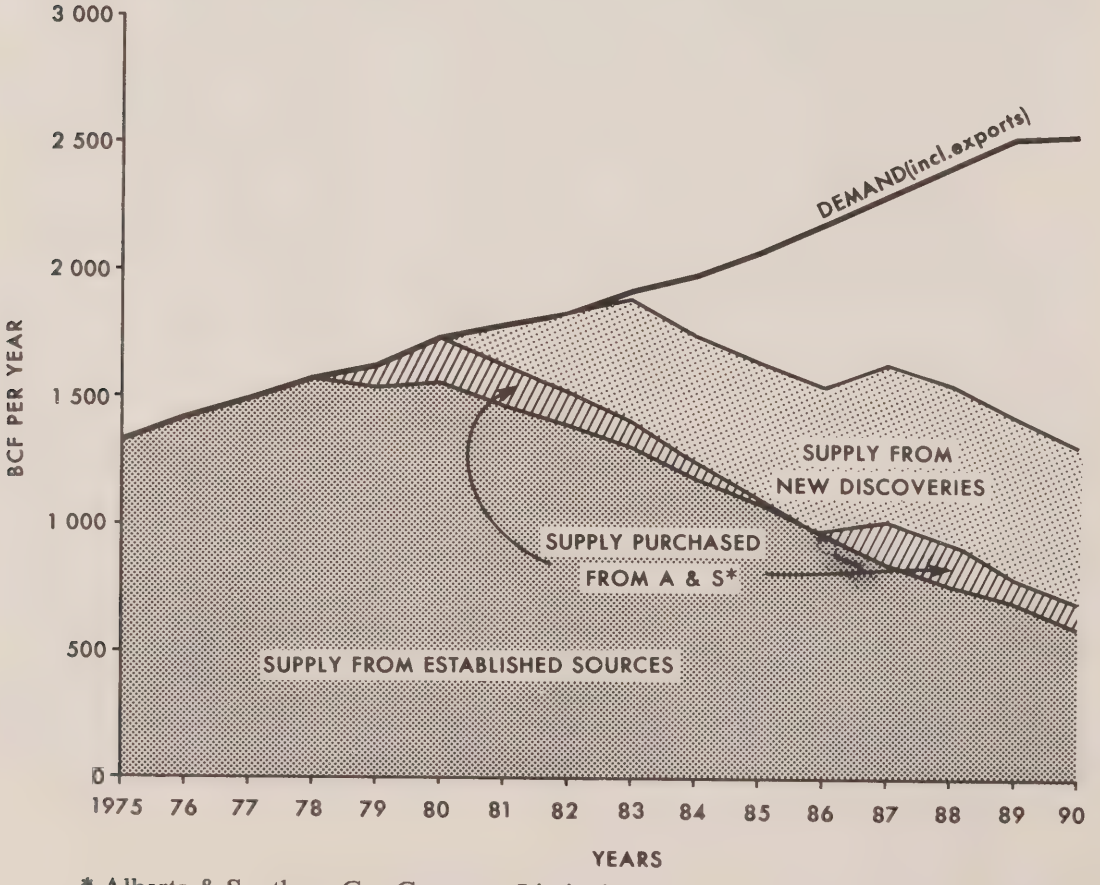
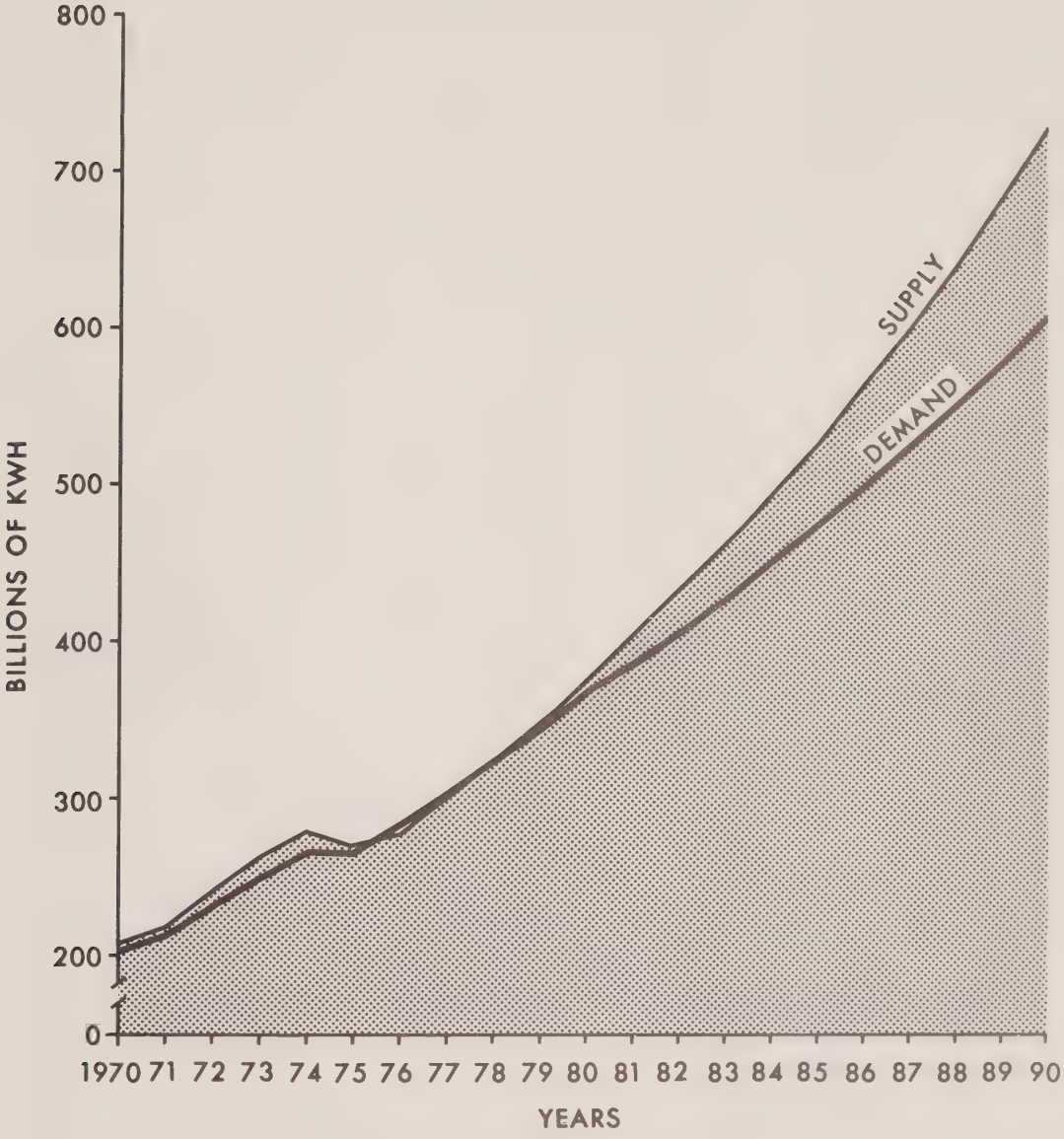


Figure 16. Natural gas demand and availability: TransCanada PipeLines system (low-price scenario)



* Alberta & Southern Gas Company Limited.

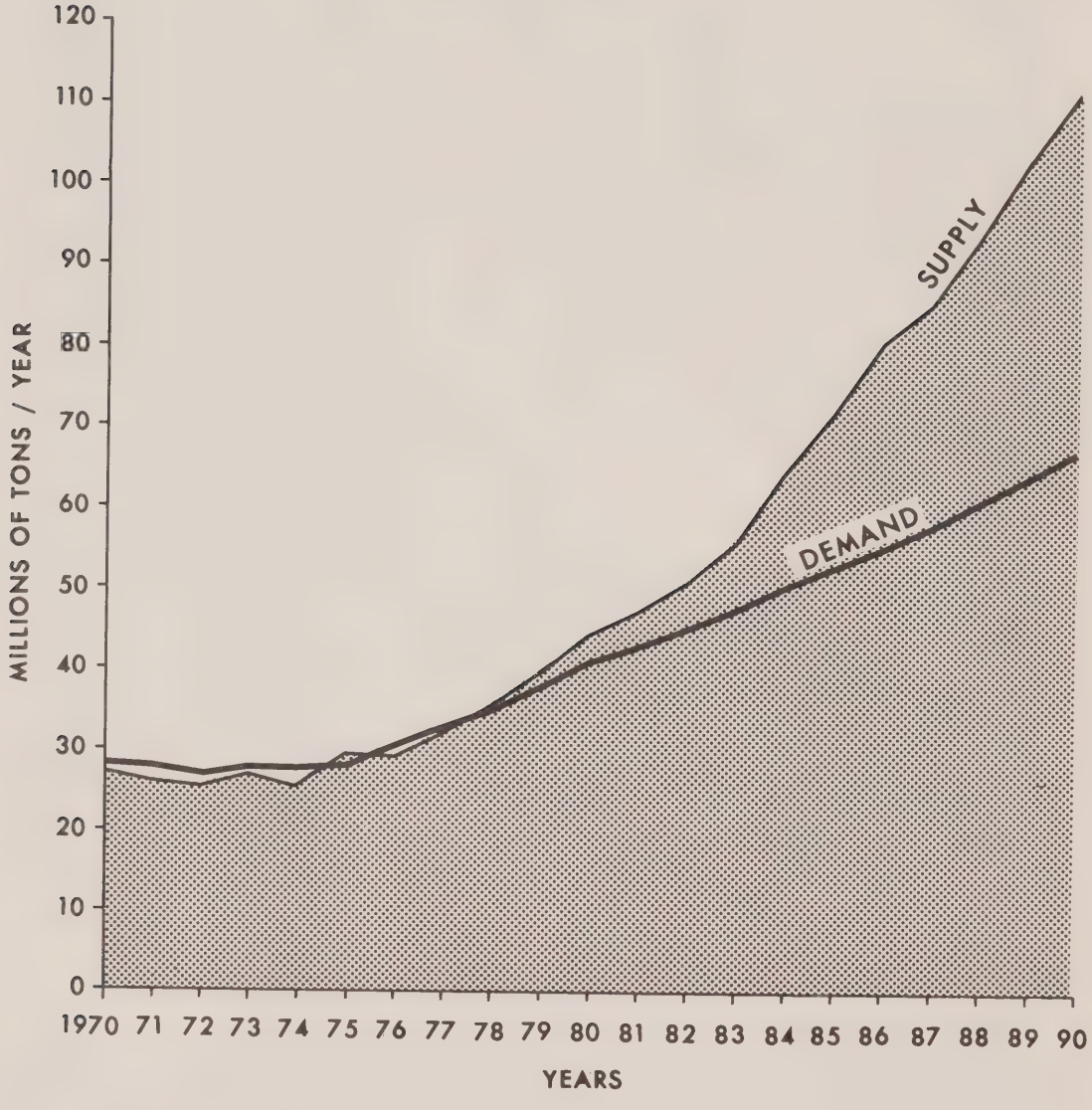
Figure 17. Domestic demand and availability: electricity (1970-1990; low-price scenario)



The increasing gaps between demand and availability for oil and natural gas more than offset the potentially available additional supplies of electricity and coal. Demands for and availability of total energy are shown in Figure 12. Under the assumption that Canadian energy prices do not increase further relative to the prices of other goods and services and under the additional, and quite stringent, assumption that interfuel substitution would take place so that the indicated supplies of coal and electricity could be utilized fully, at the expense of oil and natural gas, Canadians would still face the prospect of increasing gaps between their energy demands and domestically available supplies. Energy "shortages", in this sense, could amount to about 11% of estimated total requirements in 1980, increasing to 20% by 1985 and a little

over 24% by 1990. Such "shortages" could conceivably be met by importing energy supplies, at prices that are likely to be higher than current Canadian energy prices, or by rationing available domestic supplies.

Figure 18. Domestic demand and availability: coal (1970-1990; low-price scenario)



High-Price Scenario

The high-price scenario is based on the assumption that the price structure for domestic energy adjusts to current levels of international oil prices by the late 1970's. The price of domestic oil, delivered to Toronto, would increase to about $13.00 per barrel, in 1975 dollars.

Table 13

Domestic Demand and Domestic Availability

(High-Price Scenario)

	*1975**	*1980*	*1985*	*1990*
Oil (*thousands bbls/day*)				
Availability	1 780	1 625	1 410	1 680
Demand	1 749	2 066	2 359	2 739
Surplus (shortfall)	31	(441)	(949)	(1 059)
Natural gas (*Bcf/yr*)				
Availability	1 401	1 797	3 159	4 190
Demand	1 450	1 933	2 328	2 868
Surplus (shortfall)	(49)	(136)	831	1 322
Electricity (*billions of kilowatt-hours*)				
Availability	270	345	456	605
Demand	266	355	443	566
Surplus (shortfall)	4	(10)	13	39
Coal (*millions of tons*)				
Availability	29.7	44.3	71.7	111.9
Demand	28.0	39.8	49.5	62.5
Surplus (shortfall)	1.7	4.5	22.2	49.4
Total energy (*Btu* $\times$ 10^{12})				
Availability	7 890	8 726	11 090	14 535
Demand	7 867	9 805	11 668	14 186
Surplus (shortfall)	23	(1 079)	(578)	349

NOTES:

1. Availability of oil figures represent crude oil and equivalent including gas plant LPG's. Although Canadian net imports of crude oil averaged 137 000 barrels/day in 1975, this was more than offset by net exports of products of more than 150 000 barrels/day.
2. Availability of natural gas excludes contractual export commitments; the shortfall shown for 1975 reflects an inability to meet current export commitments because of deliverability problems in particular fields.

* Estimate.

The energy balances that might be anticipated under these price assumptions are presented in Table 13 and Figures 19-25. Projected electricity demands are compared with the low-growth supply case, designed to meet load growths increasing at 5.5% per year, and it appears (Figure 24) that through the mid-1980's, capacity would be adequate to meet the projected growth in the demand for electric power. Through the late-1980's as the rate of demand growth slows, some excess in total capacity materializes.

The coal scenario is similar to that presented in Table 12, indicating that, in terms of net availability, substantial potential may exist to substitute coal for other energy forms demanded in Canada.

At the higher energy prices assumed in this scenario, exploration and development in Canada's frontier areas would accelerate and it has been estimated that substantial quantities of natural gas could be delivered to southern markets in the 1980's assuming, as noted in Chapter 3, that possible future supplies are not constrained by environmental or social considerations, or by economic factors unrelated to price. Figure 21 indicates that, even in the high-price scenario, current shortfalls of natural gas will persist until new sources of supply from the frontier areas are brought to market. The cumulative shortfalls from 1976-1981, in the high-price scenario are estimated to be about 560 Bcf,

Figure 19. Domestic demand and availability: total energy (1970-1990; high-price scenario)

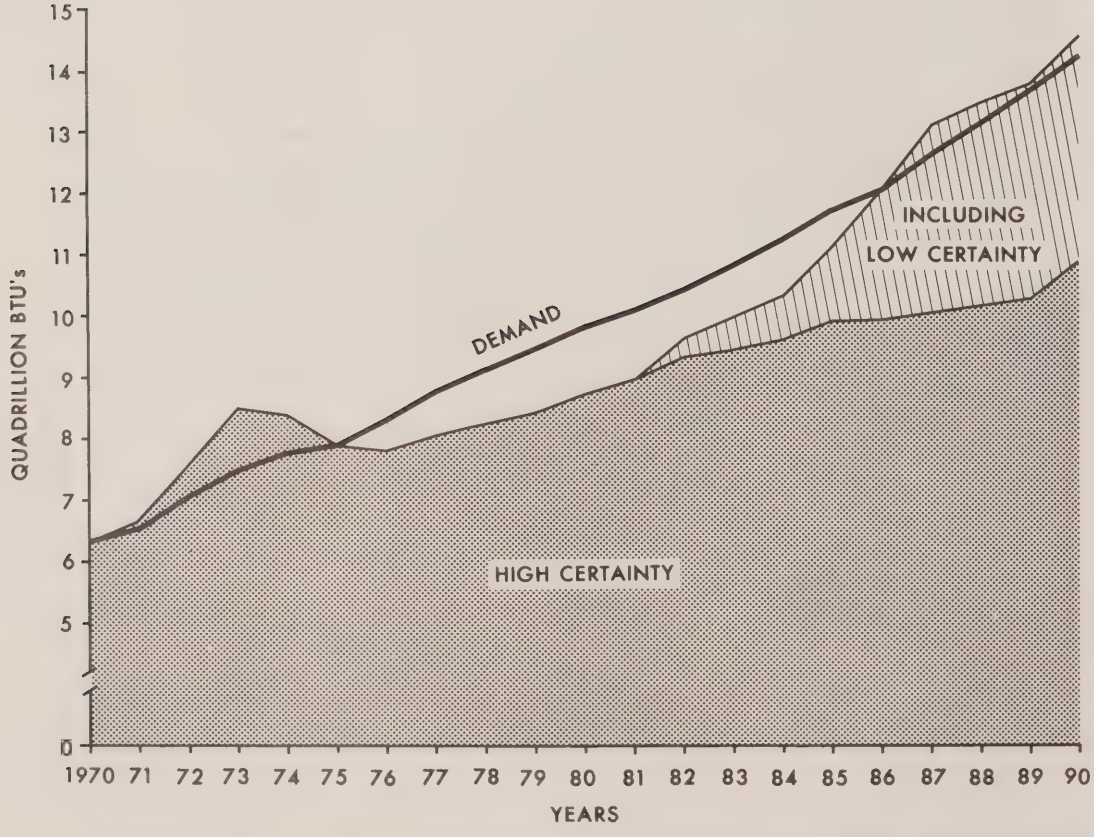
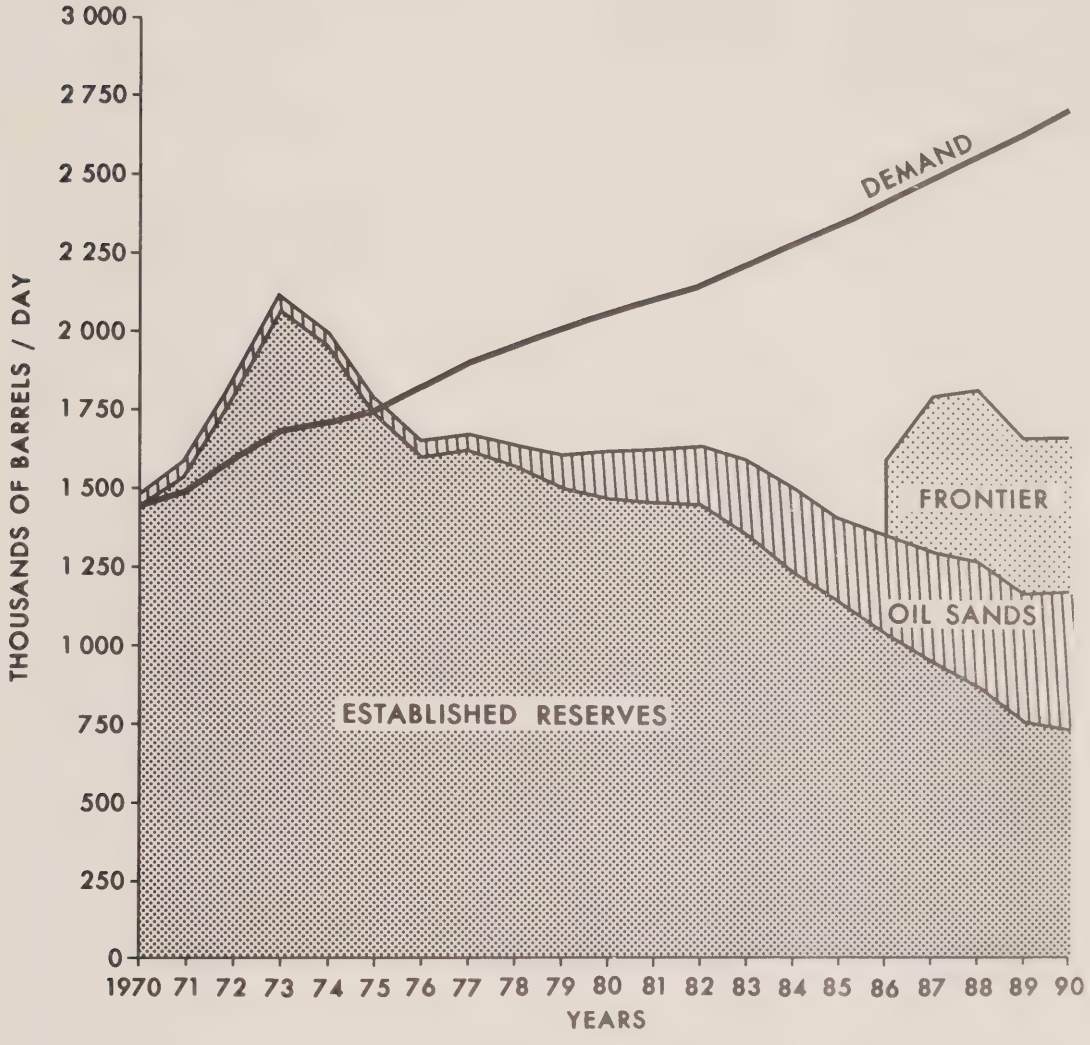


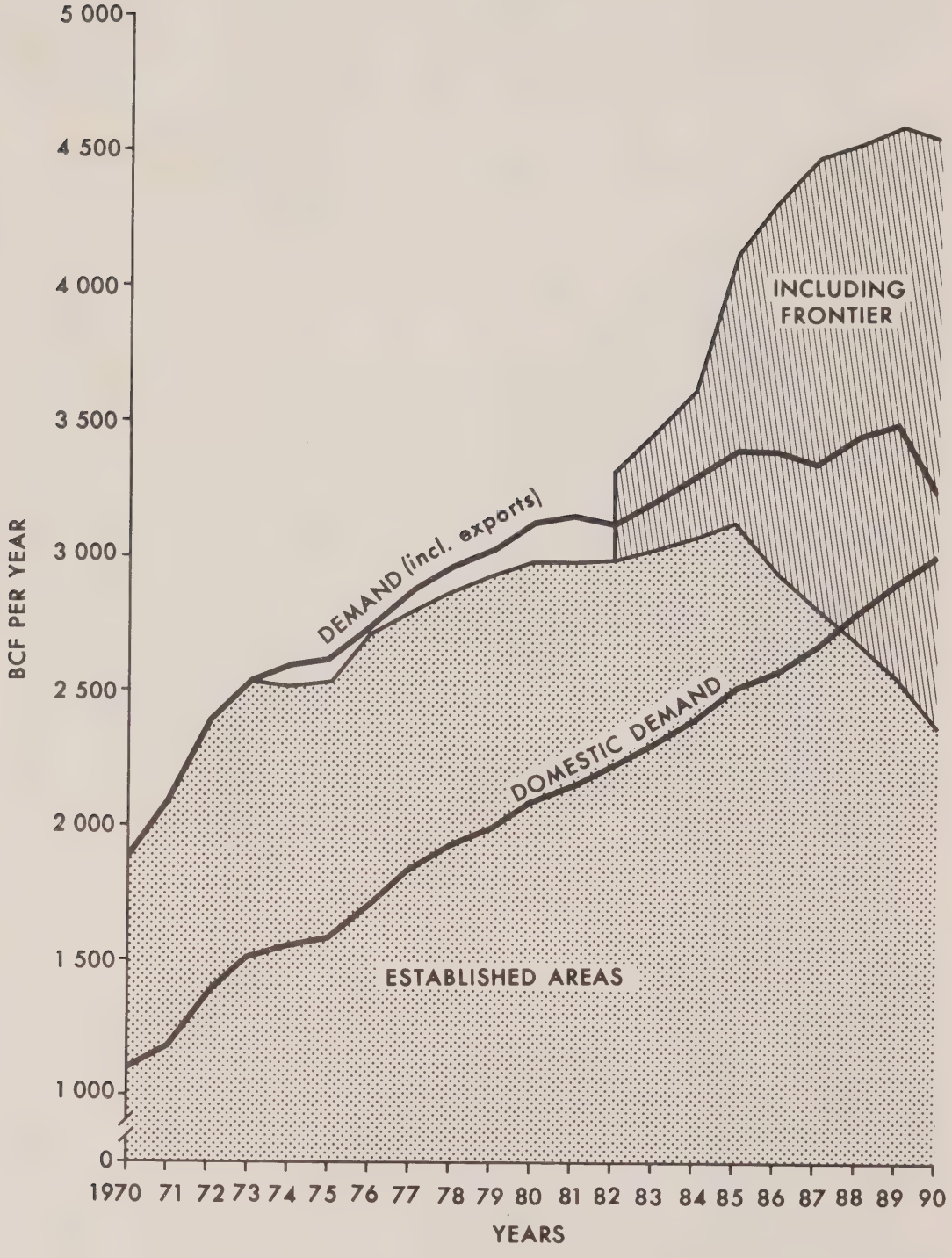
Figure 20. Domestic demand and availability: oil (1970-1990; high-price scenario)



compared with some 730 Bcf in the low-price scenario. Once again it must be emphasized that these shortfalls reflect, to a large degree, the inability to swap deliverable natural gas among existing delivery systems. While, as Figures 22 and 23 indicate, the deficit on the Westcoast Transmission system persists, it appears as though the TransCanada PipeLines system will be able to meet demands on the scale projected here until about 1985.

Demands for oil, together with anticipated availability, are shown in Figure 20. Net imports increase throughout the 1976-1990 period, although additional production from the frontier areas and the oil sands, assumed to come on stream in the late 1980's, slows the increase considerably. By 1985, net imports of oil under the high-price assumptions could amount to 40% of total Canadian oil demand. By 1990, additional domestic production could reduce this to about 38% of domestic oil demand.

Figure 21. Demand and availability: natural gas (high-price scenario)



The balances for total energy are shown in Figure 19. Under the assumption of higher prices, substantial potential could exist for substituting other energy forms, and natural gas in particular, for oil. If such substitutions could be technically and economically achieved, the total energy balance in Table 13 and Figure 19 suggests that the net availability of energy from domestic sources

Figure 22. Natural gas demand and availability: Westcoast Transmission system (high-price scenario)

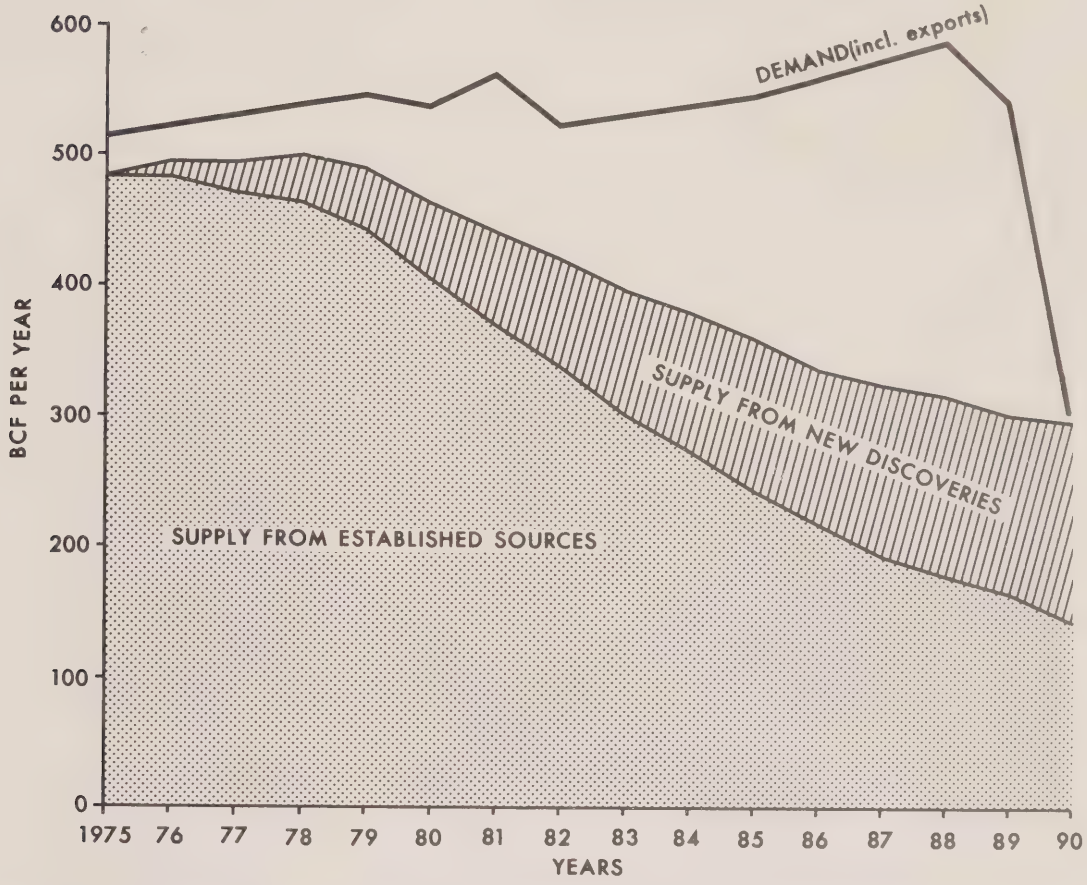
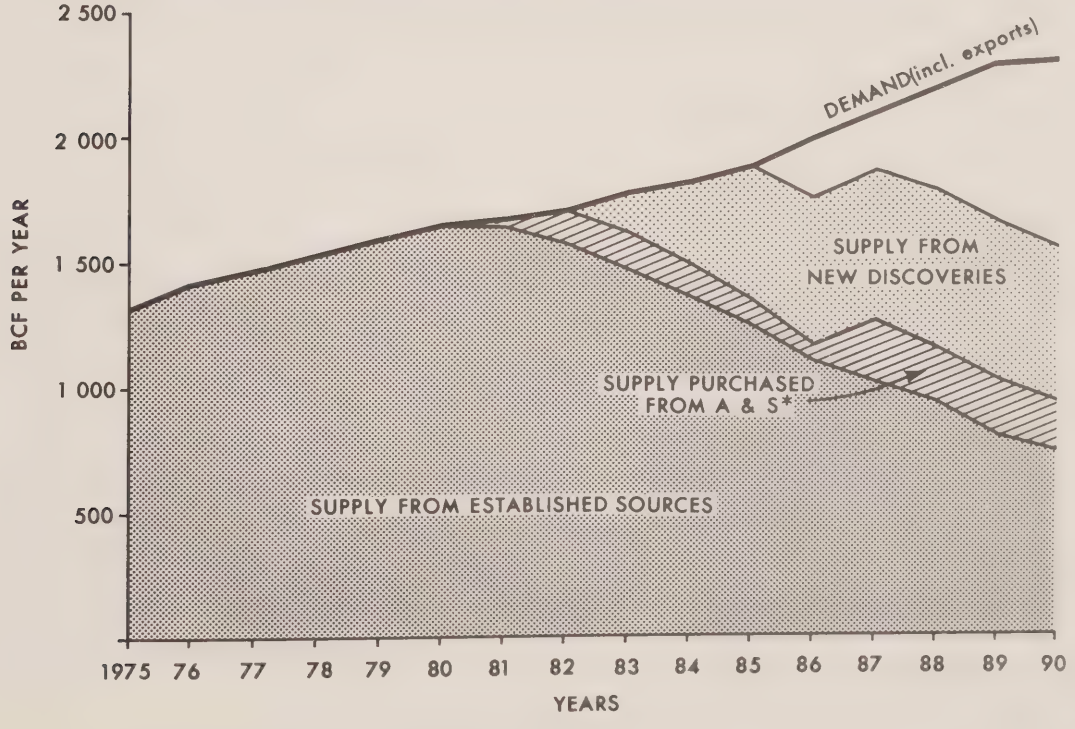
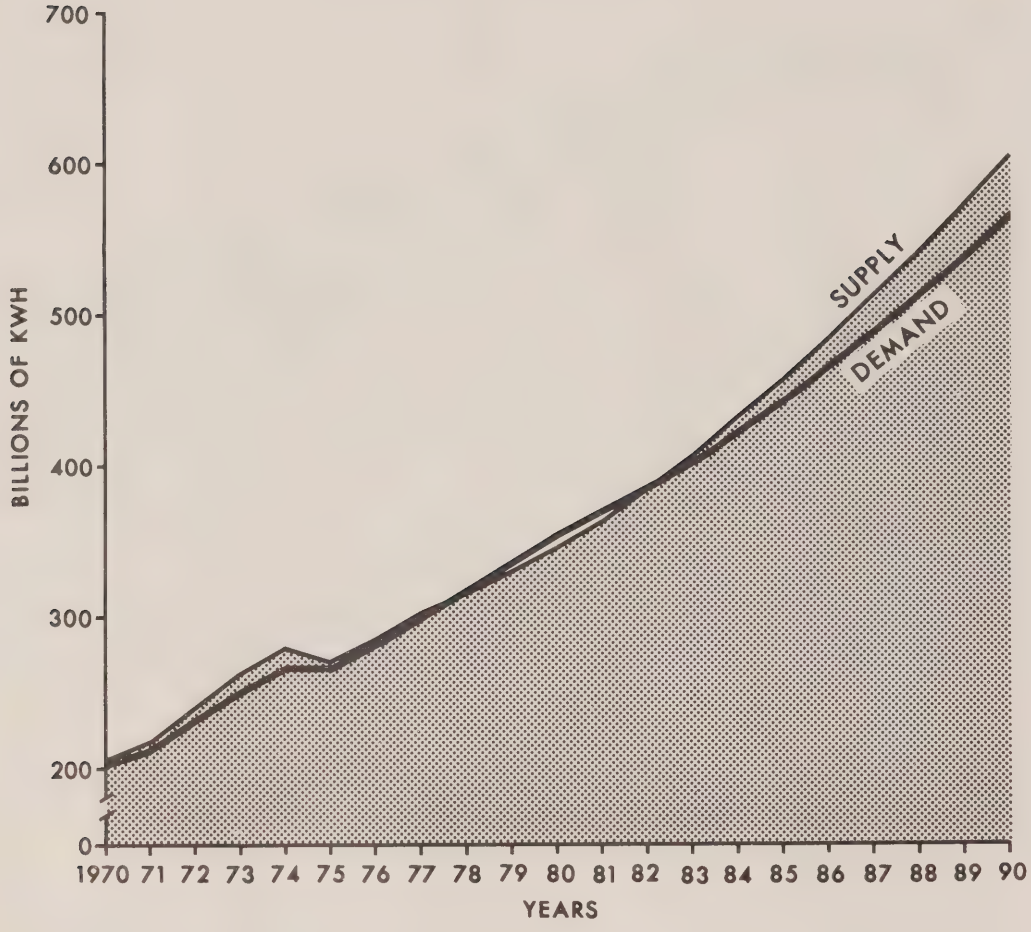


Figure 23. Natural gas demand and availability: TransCanada PipeLines system (high-price scenario)



* Alberta & Southern Gas Company Limited.

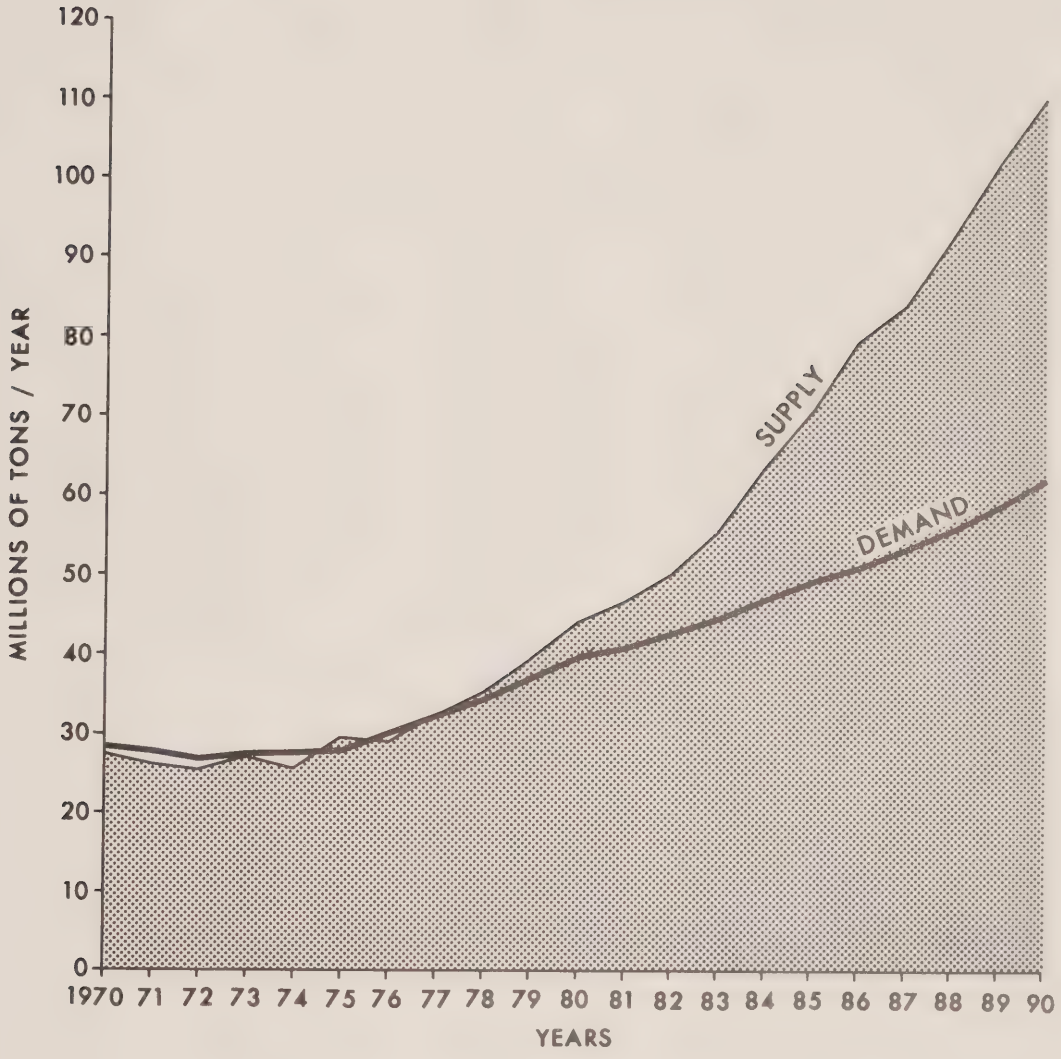
Figure 24. Domestic demand and availability: electricity (1970-1990; high-price scenario)



could increase from a deficit of about 11% in 1980 to a modest surplus position by 1990.

It should be stressed again, that the reattainment of the net energy surplus position experienced in Canada from 1970-75 is subject to a number of uncertainties. That portion of anticipated energy supplies that is highly uncertain at the current time is so indicated on Figure 19, and includes oil sands operations additional to those currently underway and frontier production. The rate and extent of developments in these areas will depend on environmental and social considerations, technological advances, the availability of manpower and equipment, the availability of financial capital, and—in the frontier areas—success in exploration activities.

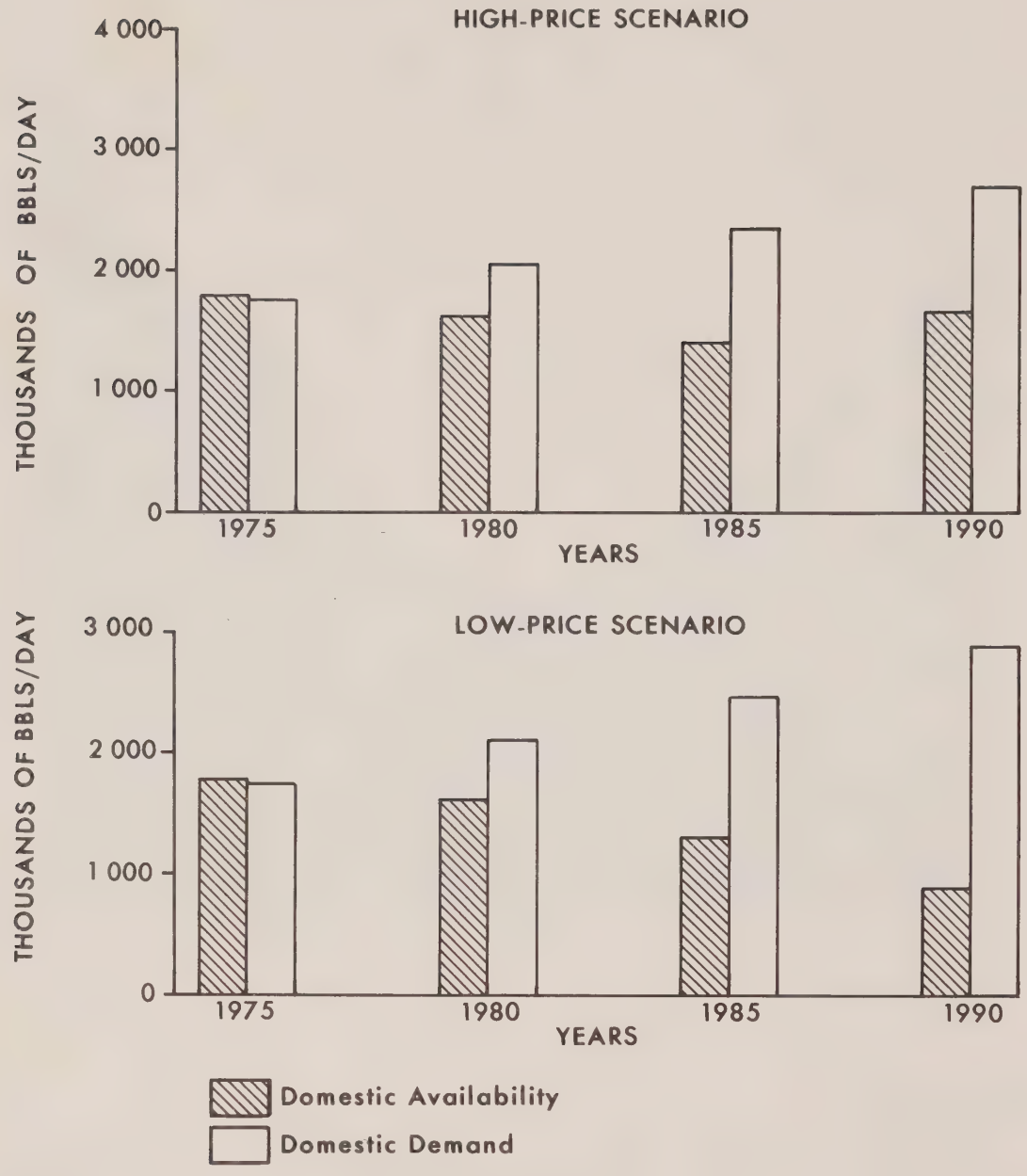
Figure 25. Domestic demand and availability: coal (1970-1990; high-price scenario)



Implications

The supply/demand balances provide an indication of the nature of the problems that are likely to confront energy policy planning through the next fifteen years. Even if the rate of increase in energy demands slows markedly in the period 1976-1990, it is unlikely that future oil demands can be supplied without increasing reliance on expensive oil imports from a few producing countries. The scenarios suggest that by 1985 Canada may be importing between 950 000 and 1.2 million barrels of oil per day, or between 40% and 47% of our total requirements. As well, problems may arise in satisfying demands for other energy sources if current Canadian energy prices do not move upward to reflect the costs of new sources of supply. Figures 26-28 summarize the estimated supply/demand balances for oil, natural gas and total energy.

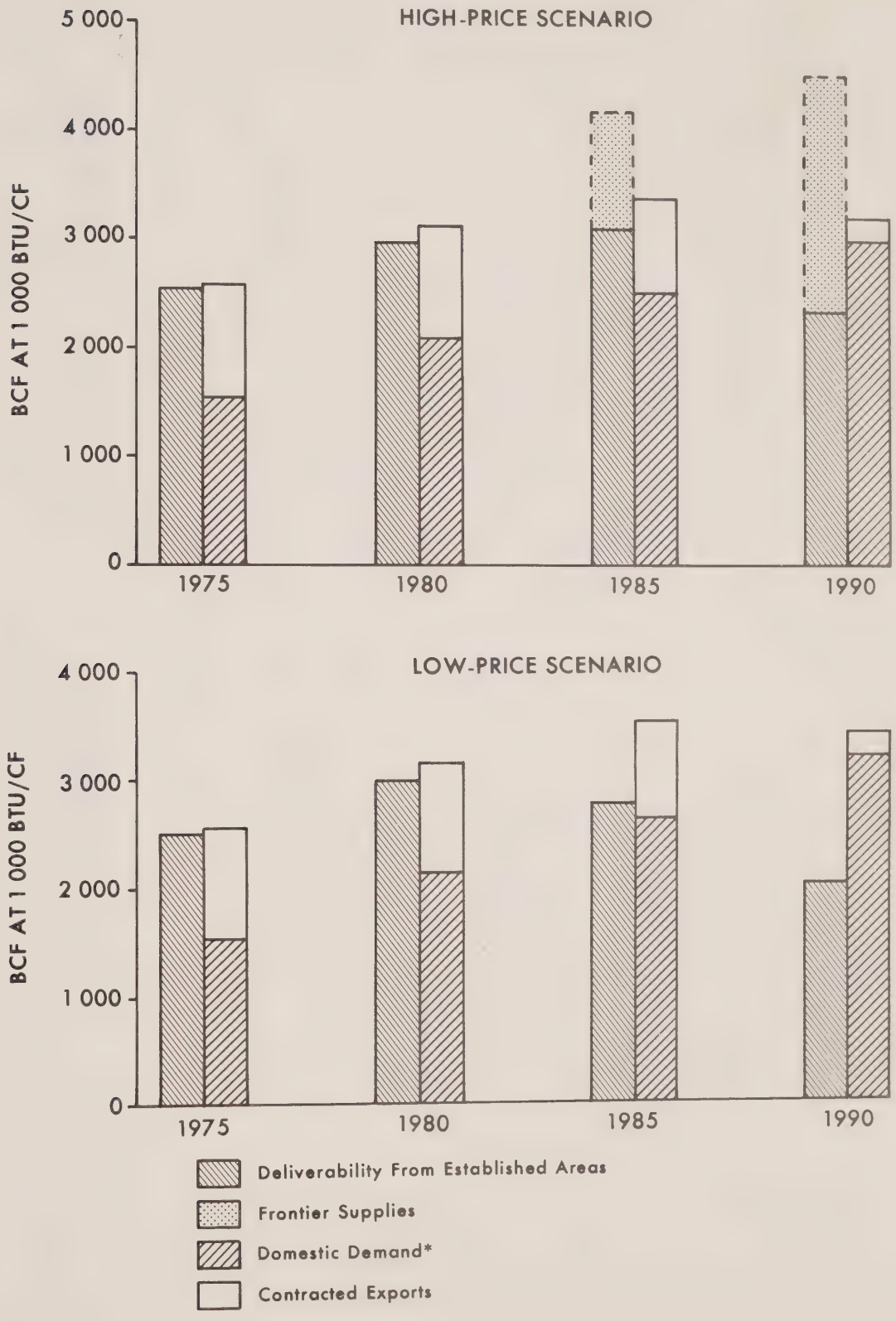
Figure 26. Domestic demand and availability: oil (two scenarios)



To appreciate the full implications of the analysis presented above, and to understand the dimensions of the problems that might arise, it is necessary to consider both the national economic context and the international energy framework within which these scenarios have been cast.

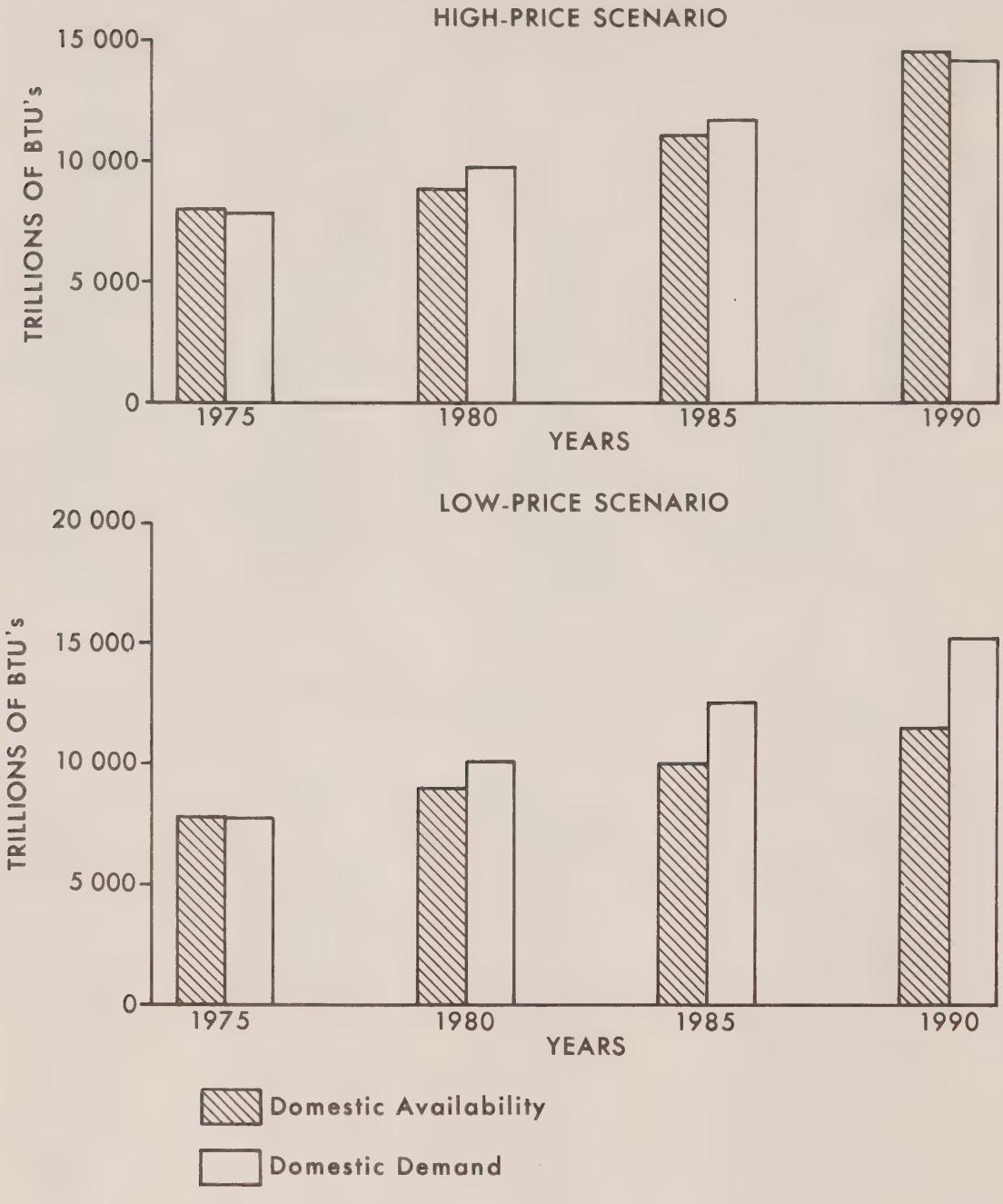
The economic aspects of the energy scenarios presented in this chapter are discussed more fully in Chapter 5. But it is important to note that the development of additional domestic energy supplies will be expensive. It is estimated that in the high-price scenario, for example, the energy industries could require

Figure 27. Demand and availability: natural gas (two scenarios)



* Including reprocessing shrinkage and fuel for exports.

Figure 28. Domestic demand and availability: total energy (two scenarios)



about $180 billion worth of manpower and equipment, purchased at 1975 prices, in order to bring forward the supplies projected. Investments of this magnitude could represent an average annual expenditure on energy-related investments of as much as 5.2% of Canadian Gross National Product over the next 15 years, compared with 3.5% over the past 25 years. Capital expenditures on this scale could result in serious adjustment problems for particular regions and sectors of the Canadian economy.

It is also necessary to consider the future development of international oil prices. The prospect cannot be dismissed that a combination of higher prices, energy conservation and the development of alternative energy sources in many countries could lead to a global supply/demand situation in the 1980's where the current real price of international oil might not be sustainable. Although it would be unrealistic to expect the real international oil price to collapse to the levels of the late 1960's or early 1970's, it could conceivably decline in the 1980's, below the level necessary to bring on stream additional Canadian supplies. To the degree that Canada and other countries take steps to restrain demand and increase supplies—in short, to alleviate the energy problems that the scenarios imply—the likelihood that the world price of oil will decline is increased. To some degree, therefore, the policy actions that are required will enhance the risk that in the 1980's Canadians could have to pay more for their energy supplies than consumers in other countries, although it should be recalled this was the situation facing many Canadians through the 1960's.

These considerations, in the context of the analysis presented above, make choices difficult. It is necessary to consider carefully the costs and benefits associated with measures introduced to alleviate prospective energy problems. It is necessary to maintain an appropriate degree of balance among alternative measures in the light of Canadians' social, environmental and economic aspirations and a sufficient degree of flexibility in the light of the uncertainties facing policy planning. The remainder of this section discusses a number of directions which offer the potential to reduce the energy problems that are foreseen over the next fifteen years.

Energy Conservation

The degree to which consumers will realize the potential that exists for using energy more efficiently depends upon the interaction of energy prices, economic institutions and social attitudes. Of these, only the price effect is clear in direction: the higher the price, the more energy conservation practices will appeal to the consumer. Current economic institutions and social attitudes were formed during an era in which Canadians felt themselves to be energy-rich and in which it was both economically sensible and culturally acceptable to use increasingly large amounts of energy in the home, in industry and in transporting people and goods from one place to another. There is no question that energy conservation is critical if we are to resolve the prospective problems of the next fifteen years in the most beneficial way. In view of the scenarios presented above, and the factors discussed in the preceding section, it is apparent that reduction of the growth in energy demand offers the most immediate, least-cost and lowest-risk policy direction to pursue.

To what degree can energy conservation measures reduce the projected rates of demand growth in the scenarios presented above? The answer is difficult for three reasons. First, there are at least three ways of defining the potential savings from energy conservation: savings that are technologically feasible without regard to cost; savings that are both technologically feasible and eco-

nomically justified; and savings that are technologically feasible, economically justified and likely to occur given public response to energy conservation initiatives. It is not always clear, when estimates of conservation potential are put forward, which definition is being used.

The second reason why it is difficult to define precisely what conservation can contribute lies in the nature of the scenarios. They do not include explicit conservation measures, but they do assume increasing efficiency in energy use because of higher energy prices. Indeed, the estimated effect of the movement to current international energy prices postulated in the high-price scenario is to reduce the level of energy demand in 1990 by about 1 000 trillion Btu's, or 6.5%. It is therefore clear that estimates of potential savings through energy conservation cannot simply be subtracted from the energy demands presented in Chapter 2.

Finally and fundamentally, the answer to the question raised above depends on the nature and extent of the measures adopted. To what degree do we want to let the market continue to allocate resources, with specific conservation measures designed only to increase information and provide incentives where appropriate? To what degree do we want to take more direct actions and deliberately seek lower rates of energy usage through regulations and mandatory controls? To assess how much conservation is a "good thing" is no easier than to decide how much supply is a "good thing". The answer must obviously depend on the relative costs and benefits of alternative measures considered.

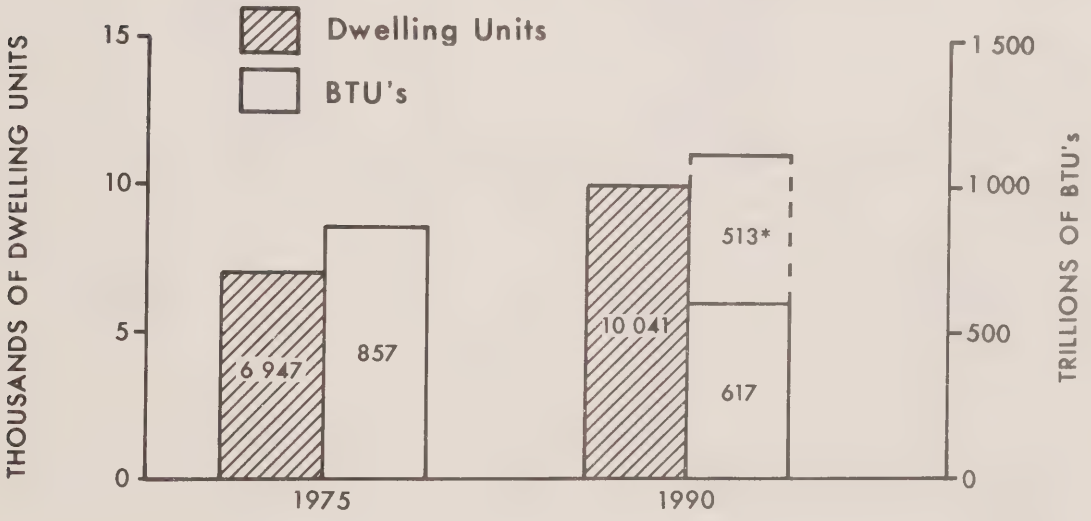
Despite such difficulties, detailed estimates of the potential for energy conservation in Canada are being prepared by the Department of Energy, Mines and Resources. The results of this assessment will be published in the near future. In terms of the second definition discussed above—those conservation savings that are both technically feasible and economically justified—the preliminary results of this assessment suggest that the potential for energy conservation in Canada is substantial indeed. Three examples, the use of energy in residences, automobiles and industry, illustrate the magnitude of the reductions in demand that can be achieved.

The greatest potential for energy savings in the residential sector lies in the more efficient use of energy for space heating. This can be attained by revising standards for new buildings, by modifying existing houses (retrofitting) and by improving the efficiency of oil furnaces, which account for over 60% of all residential heating units. Economically justified revisions in construction standards could result in energy savings in new residences of up to 50% of the energy used in similar-size residences constructed to 1970 standards. Similarly, the existing stock of houses can be improved through retrofitting to yield reductions in energy use, by 1990, on the order of 25% per unit. Oil furnaces could be improved by 20% over current efficiency levels with careful twice-a-year maintenance. Although many aspects of such programs would involve an initial

capital expenditure, calculations suggest that—even at current energy prices—this increased investment would pay for itself in the form of reduced fuel costs in about five years.

Figure 29 indicates the potential savings that could be achieved in 1990 through revised construction standards, retrofitting and increases in the efficiency of oil-burning furnaces. In 1975, total energy use in the residential sector is estimated at about 1 250 trillion Btu's. Of this, approximately 850 trillion Btu's (about 68%) were used for space heating. If the potential savings through energy conservation that are both technically feasible and economically justified were, in fact, to be realized by 1990, then the use of energy for residential space-heating in that year would amount to only 70% of use in 1975, even allowing for growth in the number of housing units. Housing units built to these energy standards would have somewhat less window area, but still more than minimum standards. Otherwise, they would be no different in appearance from those typical of current construction. Major differences would be in the increased insulation of walls and ceilings, improved vapour barriers, better weather stripping, etc. Such changes could add from $200 to $1 000 to the initial cost of new housing.

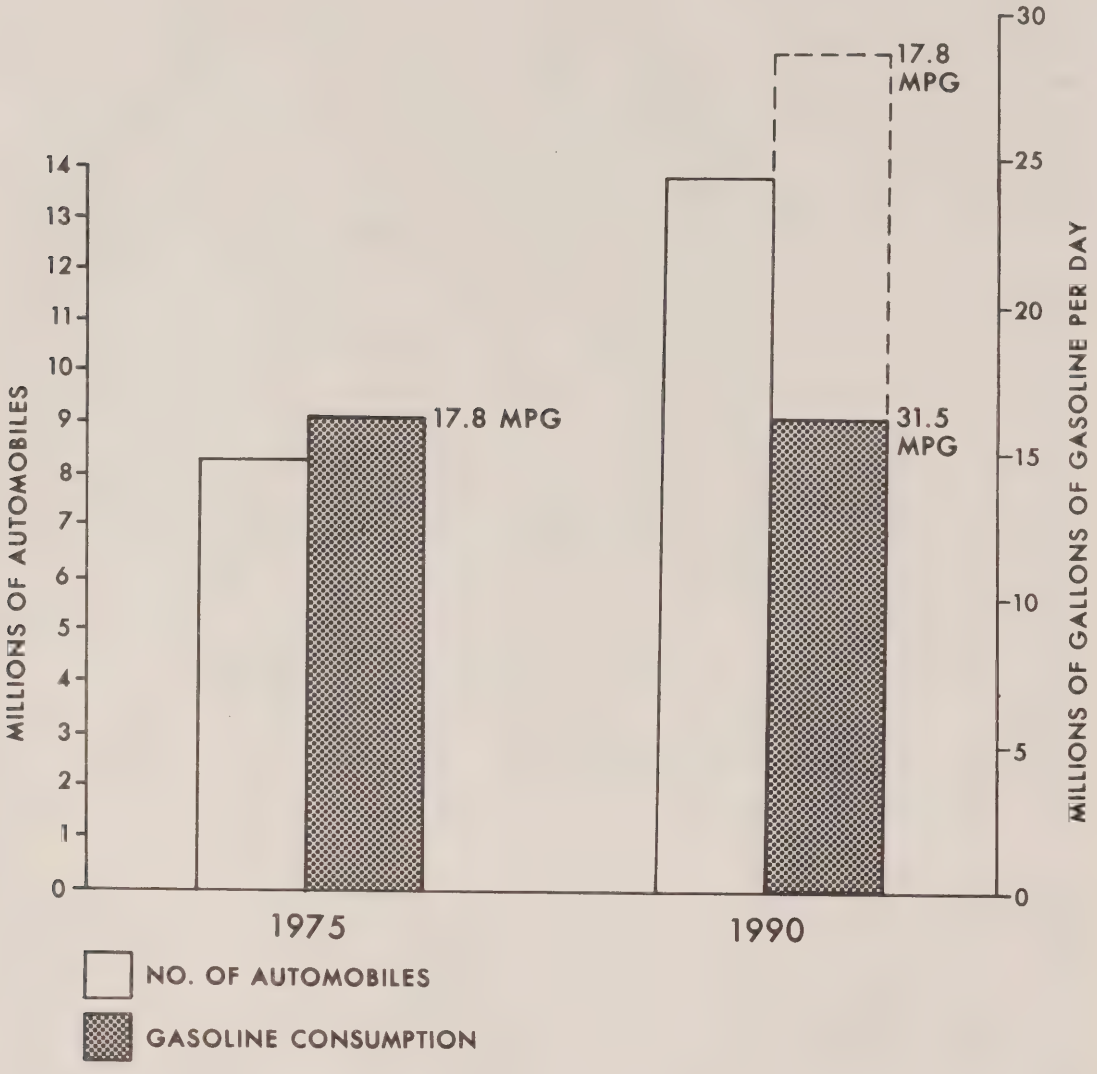
Figure 29. Energy use for residential space heating



* "Savings" attributable to improved furnace servicing (20%), new construction standards (31%), and retrofitting (49%).

Consideration of the potential for savings in the use of motor gasoline is equally striking. Recently introduced mileage standards for automobiles sold in Canada will have the effect of reducing the demand for motor gasoline in 1990 to less than 60% of what it would be with current mileage efficiency. Indeed, as Figure 30 shows, even allowing for a normal rate of growth in the number of automobiles sold, these higher efficiencies could reduce gasoline use in 1990 to a level that is about equal to gasoline sales in 1975.

Figure 30. Motor gasoline used for automobiles



In the case of industry, there is considerable potential for the reduction of energy use per unit of output, much of which will be realized in response to higher prices. Measures that can be quickly implemented and require little, if any, capital investment can yield energy savings per unit of output averaging at least 10% over a wide range of industries. Changes in energy-using processes, which would require capital expenditures and take longer to effect, could result in even more substantial reductions in energy use per unit of output. These would be particularly significant for some industries and on average might amount to 15–25% per unit of output.

These three examples are illustrative of the scope that exists for reducing energy demands through an active conservation program. It is difficult to assess the magnitude of potential reductions for total energy, since particular sectors and regions of Canada are characterized by different patterns of energy use.

It is even more difficult to calculate what proportion of potential savings might be realized, taking into account the degree to which Canadians will respond positively to conservation initiatives. A recent study* for the Science Council of Canada estimated that—for a number of specific initiatives assuming various degrees of response—total energy consumption in Canada could be reduced by about 13% in 1990. If one were to assume that this reduction occurred from a "business-as-usual" projection that did not incorporate the effects of higher relative energy prices experienced since the end of 1972, then total energy demand in 1990—allowing for conservation—would be about 14 200 trillion Btu's, reflecting an average annual growth rate of about 4.0% per year.

Preliminary results from studies that are continuing within the Department of Energy, Mines and Resources suggest that technically feasible and economically justified conservation measures—if fully implemented—might be capable of reducing the increase in energy use to about 2% per year, on average, between 1976-1990. The identification of the measures necessary to realize this conservation potential is being pursued, so that the relative costs and benefits of their implementation can be assessed. Their successful implementation would require the concerted action of all Canadian governments and the support and co-operation of all Canadians.

Interfuel Substitution

Both of the supply/demand scenarios suggest that there is substantial opportunity for interfuel substitution, away from oil and natural gas towards electricity and coal in the low-price scenario; and away from oil towards coal and natural gas in the high-price scenario. In addition, one could substitute the utilities' current expansion plan for the lower level of capacity assumed in the high-price scenario, and this would increase the potential electrical energy available in 1990 by 132 billion kilowatt-hours, equivalent to over 200 000 barrels of oil per day. The capital cost would be large, however, with the additional capacity estimated to cost about $40 billion in constant (1975) dollars. This would raise the total estimated investment requirements of the energy sector to $220 billion from 1976-1990, about 6.3% of projected GNP over that period, and could lead to serious capital financing problems for some provincial utilities. The degree to which potential interfuel substitution can in fact take place will be constrained by a number of factors, including technological developments, relative energy prices, and the rate at which existing energy-using equipment is replaced.

Interfuel substitution can be facilitated by energy pricing or taxing policies that make energy sources in short supply relatively more expensive. Alternatively, it could, as an extreme, be enhanced by regulations that would require,

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* Knelman, F. H., *Energy Conservation*, Science Council of Canada Background Study No. 33, July 1975.

for example, new residences and commercial buildings to be heated electrically, or new thermal electric plants to use coal, rather than oil or natural gas, in the production of electricity. The extent to which interfuel substitution in Canada should be encouraged beyond what is likely to occur in the absence of government initiatives is a difficult issue that cannot be resolved in a general sense without knowing more about future supply prospects for frontier oil and natural gas, and the anticipated costs of potential frontier resources relative to future costs for coal and electricity.

Interfuel substitution may be encouraged directly, at the point of consumption, or alternatively, at the point of conversion. In most cases, it would appear to be easier and more efficient to encourage such substitution at the point of conversion rather than consumption. Specific measures could entail the encouragement of hydroelectric or nuclear power, and the use of coal-fired thermal electric plants. They could include enhanced support for demonstration projects directed at improving the practicability of coal gasification or liquefaction techniques.

Similarly, initiatives which would facilitate interfuel substitution could include measures directed at using available electric power more efficiently; for example heat pumps which can dramatically reduce electricity needed for space heating, the productive use of low-grade heat,* and the increased interconnection of provincial electrical systems which would facilitate more balanced and efficient growth in electrical generating capacity. The *Phase 1* report, released by the federal government in mid-1973, suggested that Canada was moving towards an "electrical society", that electricity would account for about 40% of energy requirements by the end of the century and perhaps 90% by the year 2050.** The events of the past two years seem almost certain to accelerate these trends. Electricity is now estimated to provide about 40% of total projected demands by 1990, rather than by the year 2000, and whether or not measures should be adopted to further accelerate electricity's projected growth rate is an important, but difficult question. The answer will depend in part on the extent to which frontier oil and gas might become available and the associated costs, the rate at which electrical systems can continue to expand and provide electricity at competitive prices, and also on the rate at which sources of electrical power other than oil and natural gas can be accelerated.

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* The generation of electricity from coal, oil, gas and uranium is an inefficient process and the degree to which efficiency can be increased is constrained by the laws of thermodynamics. Currently, about 65% of the Btu content of the fuel consumed is lost in the form of low-grade heat. The estimated loss in 1990 under the high-price scenario would amount to about 1.8 quads, or about 12% of total energy requirements. To the extent that this "waste" heat can be utilized for productive purposes, such as district heating or industrial processes, it can substitute for energy forms that would otherwise have been used. Some potential uses of low-grade heat are reviewed in Cook, B. and A. K. Biswas, *Beneficial Uses for Thermal Discharges*, Planning and Finance Service Report No. 2, Environment Canada, 1974.

** *An Energy Policy for Canada—Phase 1*, EMR, 1973, Vol. 1, p. 12.

Coal

The increases in international oil prices in late 1973 and early 1974 occurred during a period of strong international demand for steel and an undersupply of coking coal. The impact was felt in the eastern United States in the first few months of 1974 when electrical utilities in that region were ordered by the U.S. Government to convert thermal units from oil to coal. The United States coal industry found it difficult to respond to the sudden increase in demand and the utilities began to compete with U.S. and foreign steel companies for the limited supplies of metallurgical coal. The scarcity of Appalachian coals was intensified by work stoppages throughout 1974, during negotiation of a new labour contract, which culminated in a general strike by the United Mineworkers of America in November. The abnormal marketing conditions arising from the combined effect of these factors pushed spot prices of U.S. metallurgical coals up to $150 per ton by the end of that year and, together with dislocations in normal transportation patterns, resulted in difficulties of supply for the major industrial consumers of southern Ontario.

Although coal producers throughout the world had enjoyed the benefits of the shift from production-cost-related pricing to the much higher prices prevailing under market opportunity conditions during 1973 and 1974, the recession in the United States and consequent softening in steel demand resulted in the stabilization of the price of coking coal in early 1975.

In 1975 the availability of oil to electrical utilities in the eastern United States eased the pressure on supplies of thermal coal to central Canada at the same time as the effects of the recession and a mild winter reduced export and domestic demand for electricity in Ontario. Prices of thermal coal have now stabilized and there is even a short-term surplus.

The current selling price advantage in relation to the cost of producing coal is being eroded rapidly, however, as the western industrialized nations adapt their energy-intensive economies to the high price of imported oil. Wages, materials and equipment costs are climbing rapidly and debt financing charges have risen sharply so that capital investment requirements for new mines have more than doubled in the past two years. In addition, producing provinces are reassessing the environmental implications of new coal developments.

A situation of concern to the federal government is the exposure of industrial consumers in central Canada to the potential unavailability of coal supplies from the United States, beyond current captive and firm contractual commitments. Major expansions by Ontario Hydro and the steel companies and current consumption by smaller industrial users in Ontario and Quebec are not secured by long-term contracts. In the course of studies of the smaller consumers it has become evident that the possible loss of continued supply of natural gas on an interruptible basis is causing concern and active consideration is being given to alternative fuels, among them coal.

The importance of coal in terms of Canadian energy self-reliance is recognized by the Government of Canada. However, federal government initiatives on development of coal policies must take into account forthcoming provincial policies related to extra-provincial marketing of coal by the three western provinces. Consultations are underway with both coal-producing and consuming provinces to facilitate the formulation of a Canadian coal policy.

Certain provincial initiatives to increase the use of coal for the generation of electricity have been evidenced by provincial utility announcements: B.C. Hydro announced in late 1975 that the Hat Creek lignite deposit would be developed for thermal generation of electricity; the Government of Alberta has stated that all future base-load generation of electricity in that province should use coal; Calgary Power and Alberta Power have recently announced major extensions to two existing plants and a new 2 200 MW plant at Dodds-Riley; and expansion of coal-fired generating capacity is planned by the Saskatchewan Power Corporation with a new plant at Poplar River.

Expansion of thermal generating capacity based on low-cost strip mining of lignite and sub-bituminous coals in the three western provinces is becoming more economically attractive as natural gas prices move towards commodity price levels with crude oil in eastern markets. In addition, such substitution permits removal of high-price, easily transported gas from the province, with increased returns from and fuller utilization of provincial resources.

Nuclear Power

The nuclear power stations existing, under construction and planned in Canada, employ the CANDU reactor developed in Canada. CANDU reactors use heavy water as a "moderator", enabling them to use natural uranium as fuel. The design is such that over 90% of a CANDU nuclear power station can be built or supplied domestically. With adequate heavy water production capacity in existence or under construction and extensive domestic uranium reserves, CANDU nuclear power stations provide an indigenously secure source of electrical energy.

Current estimates, based on recent construction experience and plans in the province of Ontario suggest that large CANDU nuclear power stations can be built at a cost of $500-$700/kilowatt (in 1975 dollars) and that the real cost may not increase. Indeed, in constant dollars, Ontario Hydro estimates that the second Pickering station under construction will cost slightly less than the first.

Despite possible reductions in real unit costs, a large-scale nuclear power program would still require very large amounts of capital. It is possible that the availability of capital rather than the estimated demand for electricity or industrial capacity, will be the major constraining factor in determining the rate of construction. A 1975 survey of Canadian industry showed a capacity to construct 3-4 reactor units per year. This capacity could be expanded, by

an investment of about $100 million, to allow the construction of 6-7 units per year. While the supply of skilled manpower is and will continue to be a problem, it has been demonstrated that this can be overcome by appropriate planning and provision of adequate training facilities.

In a study conducted in 1974 it was estimated that there would be between 27 000 and 40 000 MW of nuclear electric generating capacity installed by 1990. This was based on plans and predictions of the provincial electrical utilities and was judged fully within the capability of Canadian industry. Very recent capital borrowing constraints and reductions in demand growth have caused some deferment in these plans, and current estimates suggest an addition of between 20 000 MW (high-price scenario) and 27 000 MW (low-price scenario) over the next fifteen years.

With regard to the availability of uranium, a recent assessment* indicates that 526 000 tons of U_3O_8 would be recoverable in Canada at prices up to $30/lb. Geologists consider that there are excellent prospects of increasing these estimates as a result of the renewed exploration program. Under the uranium export policy announced in September of 1974 sufficient uranium must be reserved to provide a thirty-year supply for all nuclear power stations existing or planned within the succeeding ten years. In the assessment noted above, the total nuclear capacity expected to be in-service in 1984 was estimated to be about 18 400 MW, requiring a protected supply of 92 000 tons of U_3O_8. The annual domestic consumption in 1990 is predicted to be in the range of 4 500-6 000 tons of U_3O_8 while annual production of uranium is expected to reach 20 000 tons. The combination of known resources, geological potential, existing and potential mining capacity, government stockpiles and the uranium export policy, ensures that there will be an adequate supply of uranium fuel for an expanding nuclear power program.

For the past few years, nuclear power has been the centre of some controversy with respect to questions of safety and potential environmental effects. It has been recognized since the beginning of the nuclear power program, in all countries involved, that there are potential hazards associated with nuclear reactors and especially with the radioactive fission products produced in the fuel.

Because of this recognition, the safety aspects of nuclear reactors have been studied more intensively than for any other energy-related activity. The hazards are well known and controllable. It must, however, be recognized that CANDU reactors are evolving in design and capacity and that increased demands for safety analysis must be met by all parties concerned. The approach that has been taken is to postulate conceivable failures and to design systems in order to ensure that there are multiple defences against these failures. Concurrently with this thorough analytical approach, a rigorous regulatory regime has evolved which ensures that conservative standards are maintained throughout the design, construction and operation of nuclear power plants.

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* *1974 Assessment of Canada's Uranium Supply and Demand*, Energy, Mines and Resources, August, 1975.

The concerns over safety or environmental effects of nuclear power generally fall within one of the following categories:

- thermal effects
- radioactive releases
- radioactive waste
- accidents
- thefts and terrorism.

Thermal effects: There are possible undesirable effects from the warm water discharged from a generating station. This is not peculiar to a nuclear station but is an inherent feature of all thermal (coal, oil or gas) generating plants. It is only possible to convert about one third of the heat generated into the mechanical energy of the turbine which drives the generator. The rest is lost, through the turbine condenser, to the condenser cooling water.

Nuclear power plants generally have a somewhat lower thermal efficiency than fossil-fuelled plants, which discharge some of their waste heat up the stack with the flue gases. Nuclear plants typically discharge 40–50% more waste heat (per unit of electricity generated) in the cooling water than do fossil-fuelled plants.

Most, if not all, thermal generating stations in Canada use once-through cooling: that is, water is drawn from a river, lake, or ocean—passed through the condenser—and then returned to the same body, warmed by, typically, 8° to 9°C. This increase in temperature can be reduced at the expense of pumping more water through the condenser. With appropriate design of the water discharge system very little effect can be seen beyond the immediate area of the plant discharge and even there the effect is limited to a thin surface layer. For example, at the Pickering plant it is difficult to detect any increase in lake water temperature even at the surface beyond about two miles. The discharge systems of future plants are being designed to achieve even better dispersion. Studies are underway directed at using some of this waste heat for space heating, aquaculture, process heat, etc. There is a large amount of energy to be captured in this manner.

Radioactive releases: The increase of radioactive levels due to the operation of nuclear power plants is insignificant in relation to the normal variation around the country and around the world. The maximum radiation exposure to any individual from a nuclear power plant is about 2 millirem* per year, even for someone living right on the edge of the exclusion zone. By comparison, the natural background radiation level in the Toronto region is approximately 100 millirem per year. The natural background radiation level is greater at higher elevations because of the increased amount of cosmic radiation received. For example, the natural background radiation level is about 35 millirem per year

* A "rem" is the unit of radiation dose and a "millirem" is 1/1000 of a rem.

higher in Calgary than in Toronto. The average annual radiation dose from nuclear power and from other sources is illustrated in Table 14, which is based on a recent study by the National Research Council.

Table 14

Average Radiation Dose in Canada from all Sources

Source	*Millirem/year**
Environmental	
Natural	102.0
Global fallout	4.0
Medical	
Diagnostic X-rays	72.0
Radiopharmaceutical	1.0
Nuclear power	0.003
Miscellaneous	2.8
Total	182.0

* Average dose to an individual.

SOURCE: National Research Council of Canada, "Criteria Digest on Radioactivity in the Environment" 1973, from Table 2, p. 20 (NRCC No. 13566).

Canadian standards for acceptable exposure to radiation are based upon the recommendations of the International Commission on Radiological Protection, which was established in the 1920's and is regarded as the worldwide authority. The maximum permissible whole-body dose limit for members of the public (for radiation other than that arising from medical applications) is 500 millirem/year. The limits for the release of radioactive material from any nuclear plant are derived from this basic dose limit and similar dose limits for "critical" organs and take into account the possibility of receiving direct radiation as well as inhaling or ingesting radioactive material. Canadian nuclear power plants are designed and operated to standards such that the releases are less than 1% of the derived limits.

Radioactive waste: The most significant source of radioactive waste is the spent uranium fuel. It contains fission products, many of which are radioactive, and actinide elements produced by neutron capture on uranium during irradiation. One such actinide is plutonium, a radioactive and toxic element.

The spent fuel is currently being stored in water-filled pools at the nuclear stations. Later it will be moved to large concrete canisters designed for interim storage—for several decades. A program is underway to prove out the use of deep excavations in stable formations such as the granitic rocks of the Canadian Shield and also salt formations, for very long term storage or ultimate disposal. There are masses of rock which geologists determine have not been disturbed for at least a million years.

The plutonium can itself be used as a fuel but must first be extracted by reprocessing of the spent fuel. This is not essential for the Canadian CANDU system, but it is being studied to determine if it might be economic. If so, then the radioactive waste from the reprocessing plants would be processed into a glass matrix and placed in the deep geological excavations mentioned above.

Accidents: There is no possibility of a nuclear explosion in reactors used in nuclear power plants around the world; the configuration and nature of the fuel and reactor will not permit it. In other words a reactor cannot explode like an atomic bomb. However failures of equipment could occur and some of these might result in the rapid release of energy which would in turn damage the fuel. Under these circumstances some of the radioactive fission products might be able to escape. Therefore plants are designed to provide defence-in-depth and thereby to ensure a very high level of safety.

This is achieved by including redundancy in the design and by establishing a series of barriers to prevent any significant release of radioactive material outside the containment shell of the reactor building. In addition very high standards are required for the design, manufacture, construction and operation of the equipment.

The likelihood of an accident in a CANDU nuclear reactor, serious enough to release a significant amount of radioactive material, is estimated to be less than one in a million per year. In other words, if there were 100 reactors operating in Canada, the likelihood of a significant release of radioactive material would be less than one in ten thousand per year.

Thefts and terrorism: Concern about theft of fissile or fissionable material has been increasing, especially in the United States. The situation in that country is different from that pertaining in Canada since light water reactors require uranium enriched in the fissionable isotope U-235 and the U.S. system requires, eventually, the reprocessing of fuel and extraction of the fissionable plutonium. If the spent fuel is not processed, it would be of questionable value even to terrorists since the plutonium is effectively safeguarded by the chemically-associated radioactive fission products.

Although the possibility that radioactive materials could be used for terrorist activities cannot be ruled out, there are many other toxic substances which pose similar risks and which are much easier to obtain and to handle. The principal radioactive waste from a CANDU nuclear power plant is formed in and remains in the spent fuel. The radioactive products in the spent fuel give off gamma radiation making it hazardous for individuals to handle such fuel unless they are properly shielded and have appropriate equipment.

In summary, it is estimated that CANDU nuclear power stations could provide about one third of the new electrical generating capacity required by 1990 and could possibly supply electricity at a constant real price of about 10 mill/kilowatt-hour (1975 dollars). They can be built almost entirely of Canadian materials and equipment, and can be fuelled with Canadian uranium. Safety of the system is closely controlled by a rigorous regulatory system. In the scenarios presented above, nuclear capacity by 1990 is estimated to account for between 18% and 20% of total electrical capacity. Nuclear power could supply at least 8% of total primary energy demand in that year. The rate of expansion of nuclear power will depend upon a number of factors including the availability of oil and natural gas, prices of these energy forms relative to the price of electric power, and provincial government decisions as to the degree to which nuclear power will be relied on to supply growing requirements for electricity.

Renewable Energy Resources

By far the most important renewable resource is waterpower used to produce electricity. Approximately 75% of Canada's total electrical energy production in 1975—nearly 25% of Canada's primary energy consumption—was from hydroelectric sources. Conventional hydroelectric energy is—like wind, wave and biomass energy—an indirect form of solar energy. Substantial additions to hydroelectric capacity are projected, and this is likely to represent, for several decades at least, the most significant renewable energy resource.

Over the long term, however, it will be necessary to shift to other renewable energy sources. The potential for general application of such resources, namely solar, wind, geothermal, biomass and tidal power, has yet to be evaluated properly in a Canadian context. Estimates vary widely depending on assumptions as to the merit and capital cost of available technologies; the nature of the supporting industrial and social infrastructure; the availability, regional distribution, and price of conventional energy forms; and the annual growth of energy demand.

Under the current price situation, reflected in the low-price scenario, there have been a number of shifts towards limited use of renewable energy resources. In particular, wood wastes have been used to supplement electricity generation in pulp and paper plants and the wind generation of electricity is currently being tested by several electrical utilities and the National Research Council as a means of reducing electrical costs in areas remote from integrated systems. Feasibility studies are now in progress to apply technologies which have had

successful application elsewhere to the Canadian context, such as the use of municipal wastes for the provision of heat, electricity and synthetic fuels. A general estimate of potential for such technologies, expressed as a percentage of 1990 total primary energy demand under the low-price scenario, would be up to 1 %. This situation could be improved by an additional 1 % at no additional cost if new housing is designed to make more effective "passive" use of solar energy, for example, by such means as optimal window orientation.

Under a high-price scenario, other renewable energy technologies may become cost-competitive with conventional energy sources in the period 1976-1990. One preliminary study prepared for the Department of Energy, Mines and Resources estimates that renewable energy sources might contribute to meeting 1990 primary energy demand to the extent of 3-6%, assuming considerable effort is devoted to promoting these technologies and their commercial application. In addition to those technologies mentioned previously, this estimate includes others such as wind generators applied to electrical interconnections, anaerobic digestion of livestock wastes, and residential solar space heating by means of flat-plate collectors. These percentages may well be increased further, depending on the results of a new feasibility study into tidal power in the Bay of Fundy, currently being performed under a two year federal-provincial cost-sharing agreement with Nova Scotia and New Brunswick.

Better estimates of the potential for renewable energy forms will be necessary in the light of changing costs for conventional energy sources and projected energy supply/demand balances. Account should also be taken of possible additional benefits to be gained from some renewable energy resources in small-scale and remote applications; in enhancing security of national and local energy supply; in reducing transportation costs by increased usage at the point of generation; in reducing social and environmental costs; and in providing essential synthetic fuels to end-use sectors such as transportation in which there are few conventional substitutes. Research and development by governments and industry will be needed to improve renewable energy systems efficiencies and to reduce capital costs. Currently, the major bottlenecks to widespread implementation of direct solar space heating are construction problems and high capital costs to the consumer associated with seasonal thermal storage. Comparison, on a total system basis, is desirable to determine whether and, if so, by how much these costs exceed those that would have to be incurred to supply conventional energy. A number of federally and provincially funded demonstration solar housing projects are currently seeking answers to these and similar questions.

In the long term, conventional energy resources will eventually be depleted despite considerable improvements which can be made in the efficiency with which they are produced and used. In addition, there may well be limits to the capacity of the natural environment to absorb discharges of heat that would result from continually increasing use of conventional fossil fuels and nuclear energy. A number of renewable energy sources, notably solar, wind, tidal and hydroelectricity, would not add to these total discharges in a global context,

though they may still concentrate heat release in certain geographic areas. Further studies will be required, therefore, to identify the appropriate timing for adjusting energy policy to encourage a transition to particular renewable energy technologies.

Although estimates have been made of the potential contribution of renewable energy resources given little action by governments apart from adjusting the price of conventional energy commodities, a greater contribution could be realized, within the time frame 1976-1990, by government initiatives. Whether, and when, such initiatives are appropriate depends on an evaluation of the full range of costs and benefits associated with renewable energy technologies in the context of long-term energy policy. The potential for renewable energy sources will be assessed further in a paper which will deal with alternative energy futures beyond 1990.

Pickering nuclear generating station near Toronto—(Ontario Hydro photo).

Chapter 5. ENERGY PROSPECTS AND ECONOMIC PERFORMANCE

Continued increases in future energy requirements, declining domestic oil supplies and increasing real costs of additional energy supplies will influence Canadian economic performance in ways that are both direct and indirect. This chapter examines a number of energy-related economic issues that are likely to characterize the next fifteen years.

Capital Investment

To produce and deliver the potential supplies estimated to be available in the high-price scenario could require, over the period 1976-1990, energy-related investments of as much as $180 billion, in constant (1975) dollars. In the case of the low-price scenario, capital requirements necessary to produce the estimated energy supplies could approach $170 billion, measured at 1975 prices. The lower investment requirements of the petroleum industry under the low-price scenario are almost offset by the higher capital demands of the electrical utility sector. The projected distribution of these expenditures is shown in Table 15 and Figure 31. Over the 1976-1990 period, energy-related investment could average 4.9% to 5.2% of Canadian Gross National Product, also estimated in 1975 dollars and assumed to increase on average by a little over 4.7% per year from 1976-1990.

The time profile of anticipated energy investment is quite different in the two scenarios. The high-price scenario, in which oil and natural gas supplies are assumed to be constrained only by geology, technology and price, embodies a relatively large component of northern pipeline expenditure through the late 1970's and early 1980's, with the result that estimated investments peak both in absolute terms ($75.1 billion) and relative to GNP (6.5%) in the 1981-1985 period.

To appreciate the nature of the adjustment problems that might occur in response to capital demands of this magnitude, one must consider that, on average, energy-related investments amounted to only about 3.5% of GNP over the period 1950–75 (see Figure 32). The maximum percentage of GNP allocated to energy investment in the historical period was about 5.5%, in 1957. An average allocation of 5.2% of future GNP to energy investment would imply "higher-than-historical" expenditures of almost $60 billion, or $4 billion per year on average, measured in 1975 dollars. This average annual *increase* in energy-related expenditure, relative to historical requirements, would be roughly equivalent to about 50% of total 1975 investment in residential construction, 30% of total 1975 consumer expenditure on durable goods, or 17% of total 1975 expenditure on business fixed investment.

Figure 31. Components of energy investment, 1976-1990 (high-price scenario)

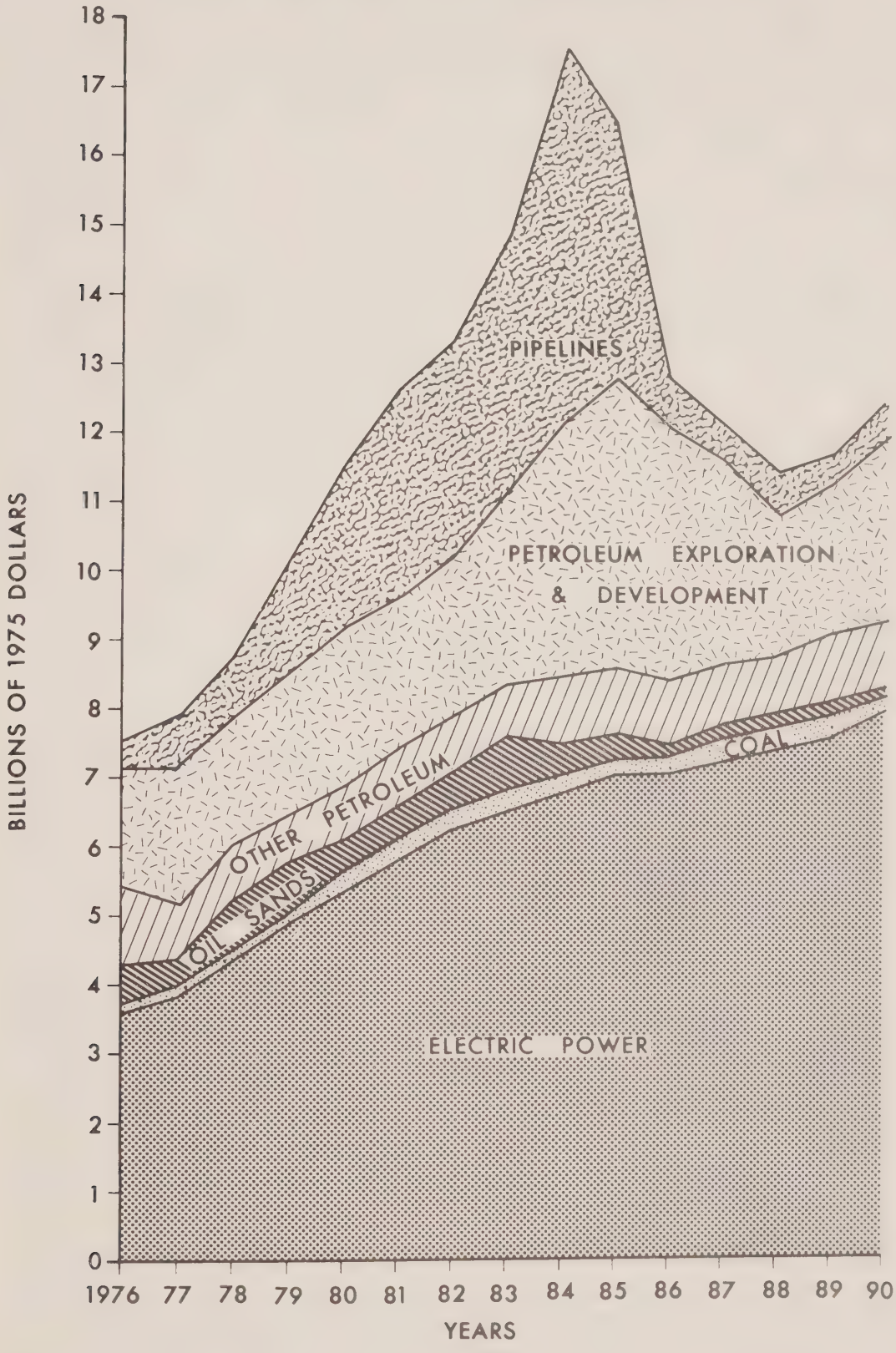


Table 15

Estimated Energy-Related Capital Requirements, 1976-1990

(High-Price Scenario, billions of 1975 dollars)

	1976-80	*1981-85*	*1986-90*	*Total*
Electric power	21.7	32.5	37.0	91.2
Pipelines	5.7	19.2	3.0	27.9
Petroleum				
Exploration and development	10.6	15.5	14.2	40.3
Refining and marketing	3.9	4.1	4.8	12.8
Oil sands	3.0	2.3	.3	5.6
Coal*	.8	1.5	.9	3.2
Energy investment	45.7	75.1	60.2	181.0
Estimated GNP	912.1	1 162.0	1 438.5	3 512.6
Energy investment as % of GNP	5.0%	6.5%	4.2%	5.2%

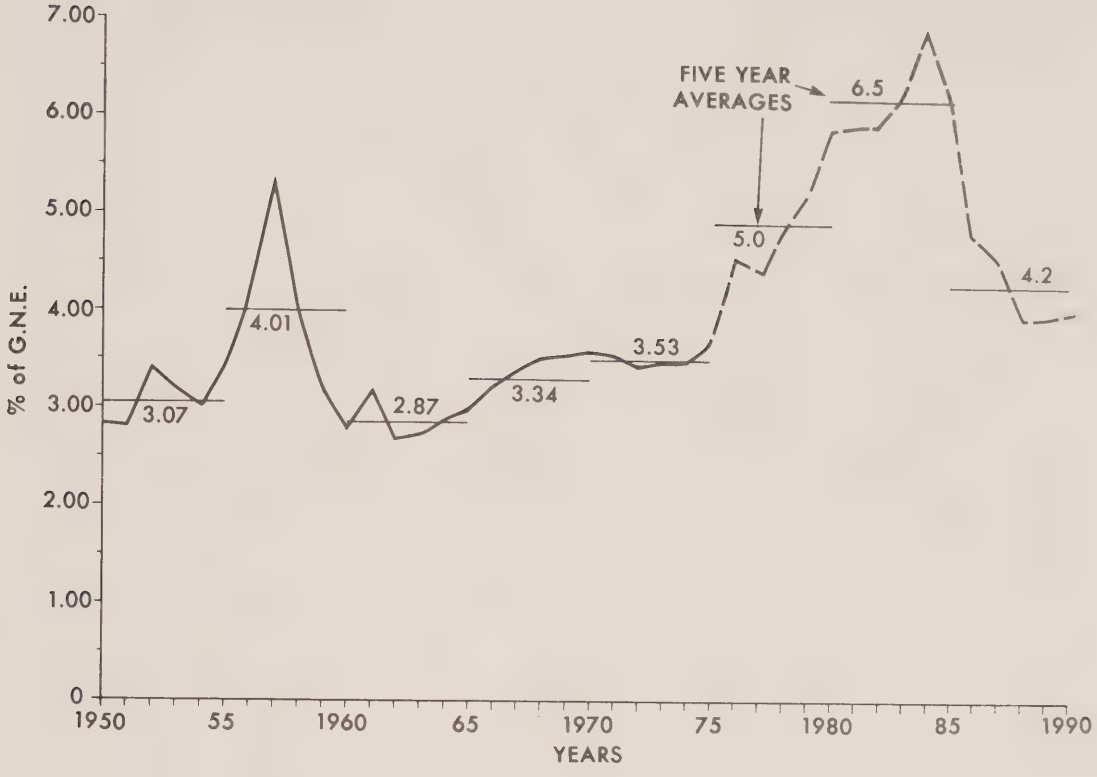
(Low-Price Scenario, billions of 1975 dollars)

	1976-80	*1981-85*	*1986-90*	*Total*
Electric power	29.2	43.0	58.4	130.6
Pipelines	2.5	2.6	2.8	7.9
Petroleum				
Exploration and development	6.3	4.8	4.0	15.1
Refining and marketing	3.9	4.1	4.8	12.8
Oil sands	1.5	.2	.1	1.8
Coal*	.8	1.5	.9	3.2
Energy investment	44.2	56.2	71.0	171.4
Estimated GNP	912.1	1 162.0	1 438.5	3 512.6
Energy investment as % of GNP	4.8%	4.8%	4.9%	4.9%

* The estimates related to coal do not include estimates of new investment necessary to upgrade transportation systems.

The prospect of energy-related capital expenditures on this scale raises a number of issues with regard to where the required funds are likely to come from, and—even more important—whether labour, with the appropriate skills, and equipment, in the required amounts, are likely to be available at 1975 prices.

Figure 32. Total energy-related investment as a percentage of gross national expenditure, 1950-1990



Considering the high-price scenario, the main calls on investment funds would be from the electrical utility sector and the petroleum industry. Together they would account for almost 83% of total anticipated investment. It is estimated that exploration and development expenditures for the petroleum industry could amount to $40 billion over the next 15 years and over $10 billion in the period to 1980. Of this latter amount, roughly 70% would represent expenditures on exploration. Under the assumptions of the high-price scenario, analysis of the anticipated cash flows of the petroleum industry over the next five years suggests that average cash flows, after operating costs and payments to governments, would exceed about $3 billion per year. After allowing for interest and dividend payments, increases in working capital requirements, and some margin for higher rates of cost escalation in frontier activities than in the economy generally, it appears that the cash flow position of the industry would be adequate to support the investment program projected through the next five years.

Capital requirements in the electrical utility sector are projected to account for a little over 50% of total energy investment in the high-price scenario and over 76% of the total in the low-price scenario. If, in the high-price scenario, the expansion of electrical capacity took place at 7%, rather than the 5.5% per year assumed, then total investments could amount to $220 billion, of which electrical power could require $130 billion. In such an event, future

investments in electricity production, relative to the size of the economy, would exceed the average investment in all energy sources from 1950–75.

There are some indications that regulatory decisions are resulting in delays in utilities' capital expansion programs. A partial alternative to such delays would be heavier reliance on debt financing which would postpone price increases to the future. The reliance of electrical utilities on capital markets, however, is already high. To the extent that utilities borrow funds with a provincial guarantee they have a competitive advantage in capital markets, but attempts to increase reliance on debt in the future could lead to concern with regard to the financial viability of the utilities and, perhaps, even the credit rating of some provinces. In a period when interest rates are high, capital costs are increasing, the capital component of new generation is increasing, and utilities are still planning to double the size of their systems every ten years, it will be necessary to raise substantial amounts of financing through internal fund generation. This means increasing electricity prices and to the degree that prices are constrained by regulatory decisions, demands for electrical power will continue to increase at a more rapid rate while the capacity of utilities to supply those demands will be impaired.

Through appropriate energy pricing, the continued efficient operation of Canadian capital markets and, in the case of the electrical utilities, continued reliance on foreign debt markets, it would appear that the capital necessary to finance the investment demands of the petroleum and electrical industries under the assumptions of the high-price scenario could be secured. For these two industries, however, the degree to which funds can be generated internally through higher energy prices will be critical.

With regard to the pipeline sector which, in the high-price scenario, is estimated to require almost $25 billion over the next ten years, more serious financing problems may occur. The construction of northern pipelines will require substantial issues of debt and equity and, until deliveries commence, will have to be financed entirely from externally generated funds. The scale of the projects envisaged, the uncertainties surrounding their construction and operation, and the timing of their possible demands on capital markets, suggest that it may be necessary to consider government financing assistance in some form. At a minimum, it will be desirable to coordinate possible demands for capital in a manner that minimizes the strains on Canadian capital markets.

Regardless of the ease with which financing may be obtained, what is ultimately required for the successful completion of an investment program is not money, but labour, materials and equipment. Financial markets are more easily adaptable to shifts than are markets for manpower and materials. To the degree that financial capital is available, but bottlenecks occur in the supply of appropriately skilled labour or materials, wages and prices may be bid up. Such effects may be particularly serious for certain regions or industrial sectors of the country. If this should occur, the real investment program envisaged, and the resulting energy supplies that were anticipated may not be attainable

at the estimated financial costs. To some degree, it is this phenomenon that has accounted for much of the rapid increases in the costs of large construction projects over the past few years. The successful implementation of an energy investment program on the scale projected here will require a high degree of coordination and cooperation among federal and provincial governments and the industries concerned, so that large projects can be phased appropriately, to avoid creating undue inflationary pressures and to minimize the problems of adjustment that are likely to occur.

Inflation

The supply/demand scenarios indicate that the nature and degree of the energy problems we face over the next fifteen years depend critically on the price level for domestic energy. Adjustment to current international oil prices would reduce future energy demands, encourage the development of new supplies and ease potential capital-availability problems associated with energy investment. At the same time, higher energy prices will impose direct burdens on energy consumers, could lead to serious structural adjustment problems for certain regions of Canada and particular Canadian industries, and will impose additional costs on all Canadians by increasing the rate of inflation.

The Government of Canada recently introduced an Anti-Inflation Program directed at reducing the overall rate of inflation in Canada. In introducing this program, however, the need for continued increases in Canadian energy prices was explicitly recognized. The Minister of Finance commented:

The situation in the energy field provides perhaps the clearest illustration of the difficult problems that must be overcome in finding and maintaining the right balance between a general policy of lowering the overall inflation rate and the need to permit an orderly upward adjustment of the relative prices of certain important products and services.

*. . .Facing consumers and producers with higher relative prices for energy is the most important single policy available to promote more effective use and production of energy.**

Attempts have been made to determine the effects that increases in oil and natural gas prices will have on the Consumer Price Index (CPI). Estimates based on a detailed analysis of the structure of the Canadian economy suggest that for every $1.00 per barrel increase in the price of crude oil and "commodity-equivalent" increase (about 17¢/Mcf) in the price of natural gas, the CPI could increase by about three quarters of one per cent. Further analysis indicates that allowing for some indirect effects of oil and gas price increases—through increases in labour costs and prices—the average impact of an increase of $1.00 per barrel for oil and an associated increase in the price of natural gas might be to increase the CPI by about 1% over a twelve-month period. For example, if the rate of inflation would have averaged 9% in the absence of oil and natural

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* *Attack on Inflation*, Policy Statement tabled in the House of Commons by the Honourable Donald S. MacDonald, Minister of Finance, October 14, 1975, p. 9.

gas price increases, then increasing the prices of those energy commodities would increase the rate of inflation from 9% to about 10%.

It must be understood that these calculations are approximations. They assume a continuation of current monetary and fiscal policies and they allow for the operation of the Anti-Inflation Program in constraining price increases to increases in costs. At the same time, the estimated effects may be somewhat high because the manner in which they were derived assumed that no efficiencies in energy use would take place.

The rate at which domestic prices for oil and natural gas are allowed to increase towards international levels must depend on our short-term domestic economic prospects and on international economic considerations, on developments in international energy markets and on our own energy problems. Balancing the relevant considerations will not be an easy task. It is essential, however, when dealing with the general problem of inflation that we avoid seeking short-term measures that will, themselves, accentuate the problems facing us in later years.

Balance-of-Payments

As long as Canada was, on balance, statistically self-sufficient in oil, the pricing actions of OPEC had no net effect on the balance of payments. Exports were sold at international prices, providing foreign exchange with which imports could be purchased. However, Canada is now a net importer of crude oil and this situation may persist through the next fifteen years. The implications for the balance-of-trade in oil will depend on the degree to which our net imports can be constrained and on future OPEC actions with regard to international prices. Table 16 shows the recent development of the current account of the balance of payments. Recent trends suggest that energy trade helped to offset a deterioration in the total merchandise balance through the early 1970's. Figure 33, which shows projected balances in energy trade, suggests that these trends should not be expected to continue through the next ten years.

The energy balances shown in Figure 33 are expressed at 1975 prices. That is, they assume no further increases in OPEC prices. For an increase of $1.00 per barrel over current levels in international oil prices, the deficit on oil would be larger by $160 million in 1980 and about $350 million in 1985. In the case of oil, net import requirements correspond to the difference between demand and availability under the assumptions of the high-price scenario (Table 13). It is further assumed that exports of natural gas will continue at their 1975 level until 1980, with the export price (in 1975 dollars) adjusting to commodity-equivalent value with imported crude oil in U.S. markets by mid-1977. Finally, the trade surplus for coal, uranium and electricity is expected to continue to increase to about $730 million in 1980 and $1.7 billion by 1985, with the bulk of the surplus accounted for by uranium exports.

Table 16

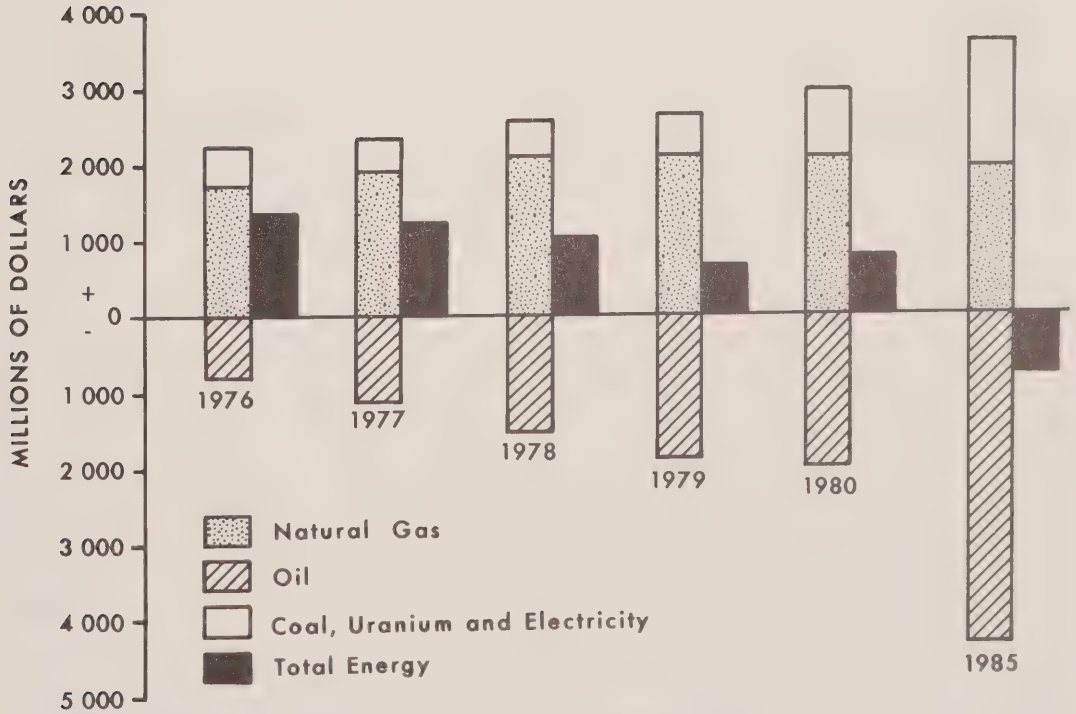
Current Account of the Balance of Payments, 1970-1975

	Balance of Trade* in:						
	Oil	*Natural Gas*	*Other Energy Commodities*	*Total Energy Commodities*	*Total Merchandise including Energy***	*Services***	*Current Account***
1970	128	201	−82	247	3 052	−2 099	953
1971	170	244	−28	385	2 427	−2 395	32
1972	343	299	14	656	1 645	−2 590	−945
1973	647	343	162	1 152	2 720	−3 039	−319
1974	1 036	488	144	1 668	1 519	−3 706	−2 187
1975 (est.)	91	1 085	55	1 231	−795	−4 690	−5 485

* Trade of Canada basis.

** National Accounts basis.

Figure 33. Balance-of-trade in energy commodities



The anticipated "swing" from 1975 to 1980 in the trade account for oil could amount, in 1975 dollars, to $2.2 billion. By 1985, the anticipated annual deficit in oil trade could approach $4.5 billion. To some extent these deficits could be offset by increased flows of foreign exchange into Canada, arising from trade in other energy commodities and from higher natural gas prices. Even in terms of total energy trade, however, the annual surplus might decrease from about $1.7 billion in 1974, when Canada was a net exporter of oil, to about $770 million by the end of the decade. By 1985 the total energy trade account might be in deficit by about $800 million a year.

The estimates of trade in energy shown in Figure 33 indicate the nature of the shifts in the Canadian balance of payments that are likely to occur as a result of our projected energy situation. These shifts are significant, and must be considered in designing appropriate economic policies for the next decade. The future evolution of the energy trade accounts must be viewed in the context of the total balance of payments (including the capital account) as it is expected to evolve. In particular, the energy-investment requirements discussed above could lead to increased inflows of foreign capital which could, to some degree, offset the deterioration in the energy-trade account, although such foreign capital flows would entail interest and dividend payments extending into the future. Energy policies cannot and should not be directed primarily at alleviating trade imbalances in energy. Nevertheless, to the degree that energy policy initiatives can contribute, among other things, to reducing potential balance-of-payments problems, such initiatives should be pursued.

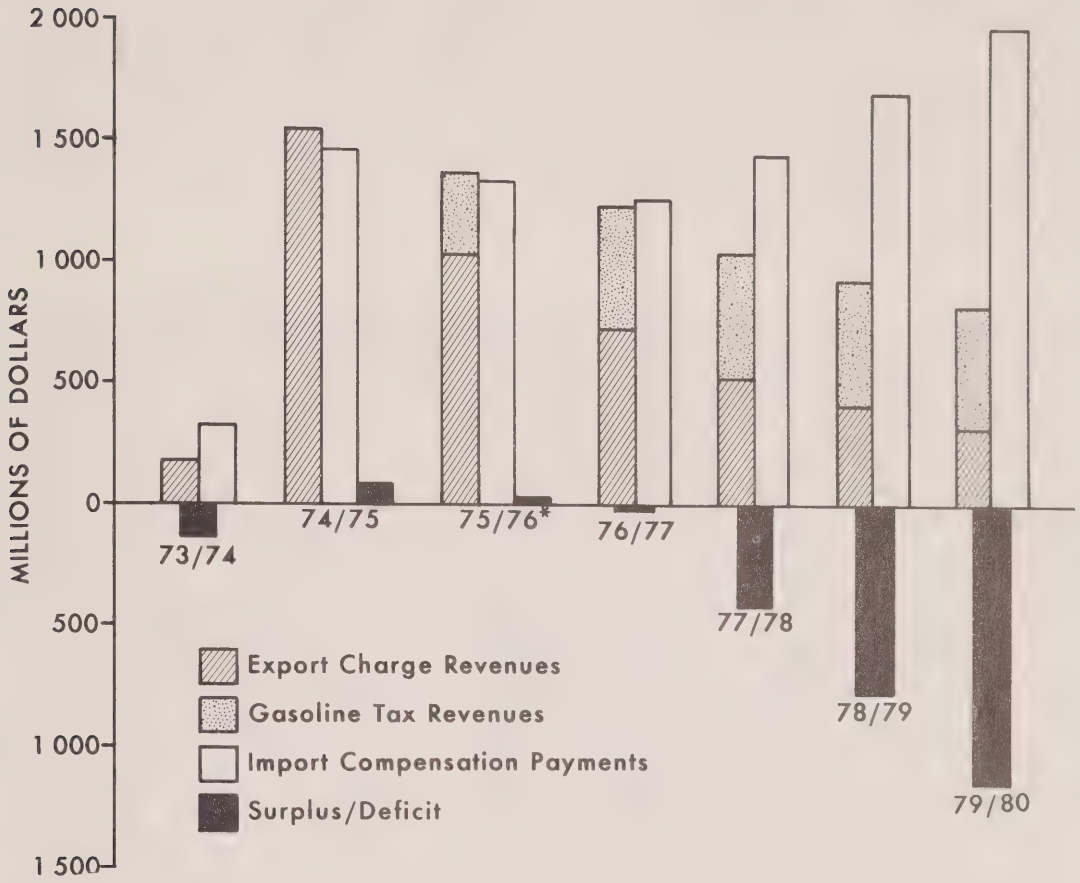
Oil Import Compensation Fund

A fourth area where energy developments will have major implications for economic performance, and the level of government expenditures in particular, is with regard to the Oil Import Compensation Fund. Revenues from the oil export charge and special excise tax on motor gasoline flow into this fund and are used to subsidize importers of oil so that consumers in all parts of Canada can purchase oil at prices consistent with the agreed domestic wellhead price. Up to and including the fiscal year 1975-76, accrued liabilities roughly balanced accrued revenues.

After the price of Canadian oil increased to $8.00 per barrel in July of 1975 the average compensation on imported oil was $3.60 per barrel. In October of 1975, OPEC prices increased by a little over $1.00/bbl and Canadian compensation payments increased accordingly, to about $4.60 per barrel. Attempts to project the future position of the Oil Import Compensation Fund depend on assumptions about both future Canadian oil prices and OPEC pricing actions.

Figures 34 and 35 show the position of the Fund over the past two fiscal years and present two estimates of its future position under alternative assumptions. The price of OPEC oil is currently frozen until the end of June 1976. What will happen in July or, indeed, through the next four years is not clear.

Figure 34. Oil Import Compensation Fund, assuming domestic prices remain at $8.00



NOTE: Assumes that international prices increase by 7% per year from 1976-1979. Average crude compensation rate increases from $4.60/bbl to $8.20/bbl on July 1, 1979. Crude exports are based on the September 1975 Report of the National Energy Board, while imports allow for eastward shipment of an average of 170 000 bbls/day through Montreal pipeline in fiscal year 1976-77, with 250 000 bbls/day thereafter. Taxable gasoline demand is assumed to remain constant at 1975-76 levels. Estimates are on an accrual basis.

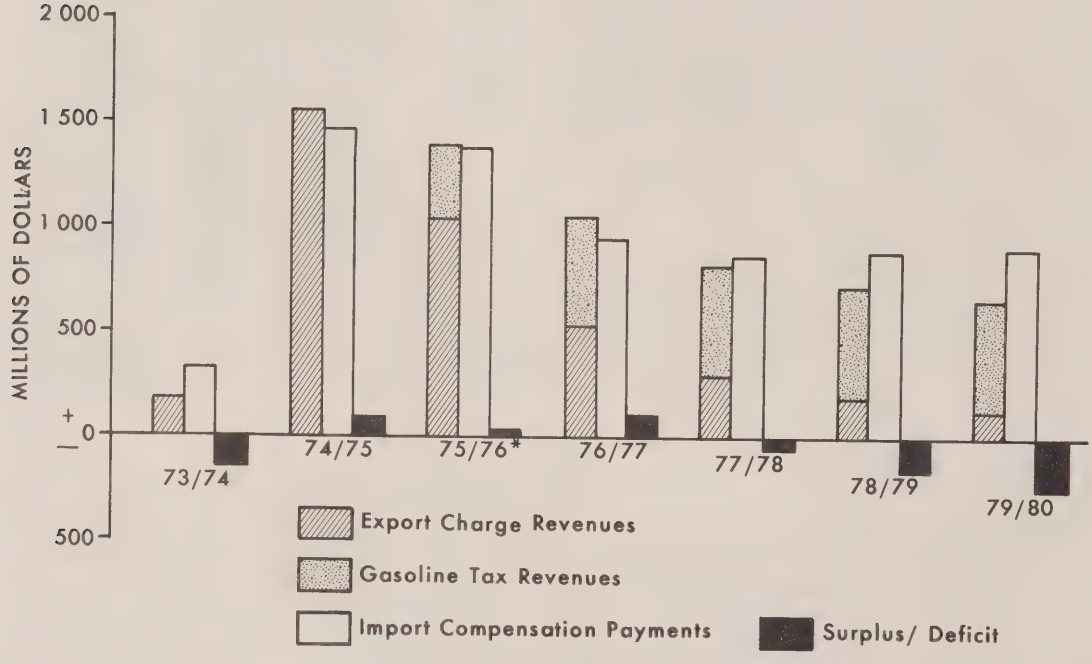
* Estimate.

Through the next few years, however, world economic growth is expected to accelerate and the global demand for imported oil will begin to increase again. In this context it seems unlikely that the real price of international oil will decrease in the near future. It has been assumed, in the preparation of the estimates presented in Figures 34 and 35 that the current international oil price escalates by about 7% per year through the next four years.

Two alternative assumptions have been made with regard to domestic prices. The first assumption, reflected in Figure 34, is that domestic prices remain at $8.00 per barrel at the wellhead. In the face of increasing international prices, the average rate of compensation would increase, leaving the Fund with a small deficit (about $15 million) in fiscal year 1976-77. The relatively

small deficit in fiscal year 1976-77 is directly attributable to reduced compensation payments because of the shipment of western Canadian oil to Montreal and to the increased revenues flowing from the operation of the special excise tax on motor gasoline over a twelve-month period. Looking beyond this fiscal year, the deficit will increase markedly as Canadian exports continue to decline and imports increase. Over the next three fiscal years, the cumulative deficit could total about $2.3 billion. Such deficits would require new sources of federal funds and represent a direct measure of the extent to which Canadian taxpayers would be required to subsidize Canadian oil consumers.

Figure 35. Oil Import Compensation Fund, assuming domestic prices adjust to maintain constant average compensation rate



NOTE: Assumes that international prices increase by 7% per year from 1976-79. Domestic prices are assumed to increase to maintain July 1, 1975 relationship with international prices. Crude exports are based on the September 1975 Report of the National Energy Board, while imports allow for eastward shipment of an average of 170 000 bbls/day through Montreal pipeline in fiscal year 1976-77, and 250 000 bbls/day thereafter. Taxable gasoline demand is assumed to remain constant at 1975-76 levels. Estimates are on an accrual basis.

* Estimate.

In Figure 35, it has been assumed that the price of domestic oil increases, together with OPEC prices, in a manner that reduces the current subsidy per barrel to $3.60 on July 1, 1976 and maintains it at that level. This would imply a decrease in the per barrel subsidy on July 1, 1976 of about $1.00 which, together with the displacement of imports by the Montreal pipeline, would lead to an estimated surplus in the Fund of about $100 million in fiscal year 1976-77. Over the following three fiscal years, however, even assuming that the subsidy

per barrel does not increase, the cumulative deficit in the Fund would be about $450 million.

In a period of declining exports and increasing imports, this deficit will continue to increase unless positive action is taken to reduce the gap between international prices and domestic prices. As Canadian oil prices rise towards international levels, average compensation payments will decrease. Canadian oil imports will grow less rapidly and the production of domestic energy sources will be accelerated.

The Manicouagan, Québec, Dam, under construction, 1969—(Hydro-Québec photo).

Chapter 6.
SUMMARY AND CONCLUSIONS

Canada's medium-term energy prospects were described in Chapters 2-5, in terms of a scenario approach. Two scenarios were presented, one based on a continuation of current domestic energy prices and a second which assumed adjustment to current international energy prices over a period of years. It must be emphasized that neither of these scenarios should be interpreted as forecasts. They represent possible developments on the basis of alternative and specific assumptions. In particular they have assumed no new government energy initiatives. In this sense they represent a number of "business-as-usual" estimates that serve to highlight problems that may arise and provide a useful "baseline" against which the appropriateness of specific policy initiatives can be assessed. Based on the scenarios presented, the following conclusions can be drawn:

(i) Even if domestic energy prices continue to increase at the general rate of inflation, the gap between Canadian demands for energy and domestic availability seems likely to increase through the next fifteen years. It is estimated that energy demands would increase by about 4.5% per year (compared with a historical average of 5.5%). It is also estimated that at current prices further oil sands developments, and the production of oil and natural gas from Canada's frontier areas, would not be economically practicable. Net oil imports could amount to 47% of Canadian oil demand by 1985 and 68% by 1990.

(ii) At domestic energy prices in the range of current international oil prices, Canada might regain a position, by the late 1980's, where net domestic availability of energy exceeded domestic energy demands. Higher prices could reduce the average increase in energy demands still further, to about 4% per year, and would stimulate the production of additional resources from Canada's frontier areas. Probable dates when frontier resources could be made available must be tentative since they will depend on the results of drilling programs, on decisions not yet taken with regard to delivery systems and, most critically, on the assessment of the social, environmental and economic costs of frontier resources. It should be stressed that even under the high-price scenario it is possible that Canada could remain a substantial net importer of oil through the 1976-1990 period, relying on foreign suppliers for as much as 40% of our domestic demands in 1985 and 38% in 1990.

(iii) The provision of additional domestic energy supplies will be expensive, requiring in the range of $180 billion worth of manpower and materials, purchased at 1975 prices, over the next fifteen years. The magnitude and timing of such investments suggests that strains on markets for labour and capital equipment may result. In addition these requirements may necessitate some adjustments in Canadian financial markets. Recourse to foreign capital,

while it could ease the balance-of-payments strains associated with continued oil imports, could lead to conflicts with the Canadian ownership and participation objectives of the federal government. It will be necessary for governments and industry to coordinate the planning of large investment projects so that they can be phased and completed in an appropriate manner.

(iv) Even assuming that the world price does not increase in the future, it is estimated that the balance of trade in oil could swing from a surplus of about $1.0 billion in 1974 to a deficit of about $4.5 billion by 1985. In the early part of this period the deterioration in oil trade will be offset by higher prices for natural gas exports. Through the entire period it may be partially offset by growing surpluses arising from trade in other energy commodities and by foreign capital inflows related to energy projects. The overall implications of swings in energy trade must be assessed in the context of the total balance-of-payments situation as it is expected to evolve.

(v) In addition to exacerbating Canadian supply/demand problems for energy, a continuation of current domestic oil prices could lead to substantial deficits in the Oil Import Compensation Fund, requiring the subsidization of oil consumers from general revenues. Estimates suggest that such deficits might be about $15 million in fiscal year 1976-77 and total close to $2.3 billion over the following three fiscal years. An upward adjustment of Canadian oil prices to levels that would maintain the gap between domestic and international prices at the level prevailing on July 1, 1975 would result in a surplus of about $100 million in the fiscal year 1976-77 but—as exports decline and imports increase—would lead to a cumulative deficit of about $450 million over the following three fiscal years.

(vi) The necessity, in the light of our energy situation, of moving domestic oil prices towards international levels will impose additional costs on Canadians and will have implications for the federal government's Anti-Inflation Program. Higher oil prices will lead to higher rates of inflation, although the existence of the Anti-Inflation Program can be expected to reduce the impact of higher oil prices on consumer prices. Inflation is a critical problem which must be resolved but it is necessary, in seeking the best ways to deal with it, not to impose solutions which will result in greater problems in the future.

(vii) The scenarios suggest that our medium-term supply/demand situation for energy poses serious potential problems, which could adversely affect domestic economic performance and Canadians' living standards over the next fifteen years. The successful resolution of these problems will require government initiatives directed at encouraging energy conservation and interfuel substitution. The identification of appropriate initiatives, particularly for interfuel substitution, is difficult because of the current uncertainties with regard to the magnitude and location of potential frontier resources and the anticipated environmental social and economic costs of delivering them.

Frontier exploration for oil and gas is a continual battle against the elements —(Imperial Oil Limited photo).

Section IV
A NATIONAL ENERGY STRATEGY

Chapter 1. INTRODUCTION

It is clear from the scenarios presented above that Canadians will face a number of energy-related problems over the next fifteen years, with direct implications for the healthy functioning of our domestic economy. These problems stem directly from the anticipated costs of additional energy supplies, the loss of self-sufficiency in oil and the prospect of continually increasing net dependence on foreign oil suppliers for at least the next ten years.

Canada is a major trading nation and Canadians are very much aware of the benefits to be gained through international trade. Our position with respect to oil, however, is different from that with regard to most other commodities. Oil is our single most important energy source and will continue to be for some time. The prospect of becoming net importers of oil, to the extent that 40%–47% of our total requirements may have to come from abroad by 1985, poses considerable problems. The degree of control that is currently exercised over the international oil market by OPEC, the extent to which that cartel has managed to manipulate international oil prices, and the demonstrated willingness of some oil-exporting countries to use oil as a "political weapon", constitute persuasive evidence that increasing our dependence on imported oil will decrease the degree of control we have over our future economic and social progress. *The prospect of increased dependence on imported oil, in today's circumstances, carries with it a degree of risk—both economic and non-economic—that no Canadian, in ordering his private affairs, would accept without some form of insurance.*

Energy policy planning in Canada is paradoxically difficult because we are in the fortunate position of having a number of possible options, a number of directions in which we can move. Unfortunately, our knowledge of the geological, technological, environmental and economic factors associated with many of the available options will only be unfolded over the course of many months, even years. With regard to new reserves and the costs of finding, developing and delivering them to market, good luck may be just as important as good management—perhaps even more so. There is, therefore, an unavoidable lack of precision in assessing accurately the costs, the benefits and the risks attending alternative courses of action. The scenarios sketched in Section III suggest that we have substantial potential to manage our energy future—including both the supply and demand aspects—in a way that minimizes our risks, to the benefit of all Canadians. Such a course or management strategy will have to be supported by a number of energy policies. It will be expensive, will require structural adjustments to the manner in which our economic system functions, will necessitate a reordering of priorities and will demand effective federal-provincial coordination on energy matters. Such a course is not without risks, but there is no risk-free solution for Canada. There are only degrees of risk related to particular objectives. The Government of Canada believes the strategy outlined here will maximize our opportunities with least risk.

Chapter 2. A NATIONAL ENERGY STRATEGY: THE GOAL

The overall objective of the national energy strategy which the Government of Canada has adopted is *energy self-reliance.*

Self-reliance in energy can be measured by the degree to which we are independent of imported oil from insecure sources: the greater our independence, the greater our self-reliance. We do not necessarily want to eliminate oil imports. We do want to reduce our vulnerability to arbitrary changes in price or prolonged interruptions in supply. This we can accomplish: first, by reducing our oil imports to the greatest extent possible and desirable in the context of our general economic, environmental and social objectives; second, by ensuring that we maintain a degree of emergency preparedness sufficient to withstand possible supply curtailments with minimal economic and social consequences.

Substantial opportunities exist for reducing our future oil imports, through policies directed at lowering the rate of growth of energy demands, accelerating the discovery and production of domestic energy supplies, and encouraging the substitution of domestic energy sources for imported oil. The continued phasing of domestic oil prices towards international levels and the appropriate pricing of natural gas are essential to the realization of these opportunities. But the operation of market forces will have to be supplemented by specific federal and provincial government initiatives. Conservation measures are an obvious example. These and other measures are outlined as elements of the strategy.

Some Canadians have suggested that the objective of a national energy strategy should be self-sufficiency in oil and other forms of energy. However desirable that might be, it is clearly not a realistic objective in the next ten years. Nor can we be sure that it is realizable in fifteen years.

The problem with self-sufficiency is that it fails to recognize a fundamental fact of life, that is that this policy choice is not really open to us at this time for a number of technical, economic and social reasons. For example, we do not yet know whether we will discover oil in sufficient quantity or what the costs of producing it and bringing it to market might be. All policy choices which aim at greater or lesser degrees of self-sufficiency involve costs: higher energy prices; greater investment in energy at the expense of other goods and services; and structural adjustments in our social and economic institutions in order to utilize energy more efficiently and to use different forms of energy. Some options will be more costly than others, and there may well come a point at which the option that offers Canadians the greatest benefits—even allowing for a certain degree of risk—would involve some continued reliance on imported oil supplies. The goal of being able to satisfy our requirements for each energy source from domestic resources, particularly in the light of our oil situation, fails to recognize that the costs of meeting this objective might well be too high.

Another formulation of the self-sufficiency argument is that we should define self-sufficiency as that condition, on a total energy basis (oil, natural gas, coal, electricity, and possibly uranium), where our exports cover our imports. This is the position we occupied in the early 1970's. In terms of the scenarios presented in this paper, it would involve, by the mid-1980's, exporting natural gas supplies surplus to immediate Canadian requirements in order to alleviate the balance-of-trade deficit associated with our continuing oil imports. Such a policy would effectively protect us, as we are now to some degree protected, against arbitrary manipulation of the international oil price and the net transfer of Canadian incomes and wealth outside the country. In the context of the energy situation as it may evolve, and in the context of the economic situation at the time, it may well be desirable however for us to be able to reserve our position as to whether such exports should be allowed and, if so, under what terms and conditions. Such a policy could be consistent with our objective of self-reliance. But, by itself, it would not offset the risks associated with future supply curtailments. While we were statistically self-sufficient in oil in 1974, for example, we were self-reliant only because we were able to increase western Canadian production and institute emergency shipments to eastern Canada from Canadian and non-traditional sources when our regular sources of international supplies were reduced. In the face of possible future supply curtailments, eastern Canadian consumers (and, by 1985, perhaps most Ontario consumers as well) might derive little comfort from the knowledge that Canada was exporting as much total energy as eastern Canadians had to import from insecure sources.

Self-reliance means reducing our vulnerability. It means supplying Canadian energy requirements from domestic resources to the greatest extent practicable. It is consistent with exporting energy surplus to Canadian requirements if this should be desirable. It recognizes, however, that the policies we will adopt have costs as well as benefits and a balance that provides the maximum advantage to Canadians must be found.

General Target

Given the time needed for Canadians to adjust to and adopt new conservation measures, given the long lead times for exploration and development and for the provision of transmission and transportation facilities, given also the enormous capital sums that must be deployed and given the need to focus this activity within a manageable time frame, the Government of Canada believes that we should set as our objective: energy self-reliance within ten years. This Section sets out a strategy to achieve that goal and targets to focus our efforts.

Specific Targets

Specific targets relating to our self-reliance objective include:

- **To reduce our net dependence on imported oil in 1985 to one third of our total oil demands.**

- **To maintain our self-reliance in natural gas until such time as northern resources can be brought to market under acceptable conditions.**

Other specific targets adopted by the Government of Canada relate to appropriate energy pricing, energy conservation, increased exploration and development, and emergency storage of oil.

Construction of the Sarnia-Montreal pipeline.

Chapter 3. A NATIONAL ENERGY STRATEGY: POLICY ELEMENTS

In support of the objective of energy self-reliance within ten years, the Government of Canada proposes nine major policy thrusts. These policy elements provide a coordinated framework for the development of specific programs and measures. They include

1. *appropriate energy pricing;*
2. *energy conservation;*
3. *increased exploration and development;*
4. *increased resource information;*
5. *interfuel substitution;*
6. *new delivery systems;*
7. *emergency preparedness;*
8. *increased research and development; and*
9. *greater Canadian content and participation.*

These policy areas are elaborated below. In many cases, specific examples of the kinds of programs and measures the federal government has introduced or will be proposing are indicated. The precise nature of all future energy policy initiatives will continue to be determined within this framework but will, of course, be dependent on the course of future events. These initiatives will embody the balance and flexibility that is necessary in a rapidly changing world and will reflect a changing relative emphasis among these elements as circumstances warrant. They will be developed with appropriate federal-provincial consultation, and with due regard to the social, environmental and economic objectives of Canadians.

1. Appropriate Energy Pricing

- ***Specific Target:*** **To move domestic oil prices towards international levels; and to move domestic prices for natural gas to an appropriate competitive relationship with oil over the next 2-4 years.**

It is clear that the appropriate pricing of Canadian crude oil and natural gas supplies is fundamental to our objective of energy self-reliance for Canada. The Economic Council of Canada put this issue in its proper context when it commented:*

The policy of keeping oil prices to Canadian domestic consumers below the price of alternative supplies cannot be maintained for very long; and if it were pursued

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* *Economic Targets and Social Indicators,* Eleventh Annual Review of the Economic Council of Canada, 1974, p. 60.

as a medium-term objective, it could serve to delay needed energy-conserving technological change, hasten the depletion of existing reserves, delay the provision of supplements and alternatives, lower the potential volume of savings, and perhaps foster abortive development of energy-intensive industries dependent upon the hidden subsidy for cheap oil and gas.

In addition, maintaining the price of domestic oil below the price of alternative supplies will increase our net imports of oil and thus increase the amount of Canadian incomes and wealth that will have to be transferred to oil-exporting countries. It will exacerbate our potential balance of payments problems and will increase the burden on Canadian taxpayers that would be required to subsidize Canadian oil consumers.

We must continue the process that began in April of 1974, of phasing the price of domestic oil towards international levels. Canada does not necessarily have to go to international prices. Because we have domestic resources to develop, we have a degree of independence from the oil-exporting cartel that many countries do not enjoy and that is to our advantage. But if we do not raise our prices to levels at which those resources can be found, developed and delivered, we will find ourselves in the same position as those countries that do not have domestic resources.

Canadian oil prices are lower than in any other major western industrial country. The current price of oil in Canada is $8.00 per barrel at the wellhead. The average price of oil in the United States is about $10.00 per barrel. International prices are currently frozen at about $11.50 per barrel in the Persian Gulf ($13 per barrel delivered to eastern Canada) but they may increase again on July 1.

It is the federal government's objective to see domestic oil prices increase to a level sufficient to bring on new Canadian supplies. To the degree that this level is lower than international oil prices, it is a differential for the benefit of Canadian consumers and Canadian producers, industrial and agricultural. Should it be the case that a price sufficient to bring on Canadian supplies were to exceed international prices, it would be necessary to make a further decision, as we did in 1961, as to whether it is in our best interest to continue to develop our own resources or to import supplies from other countries. Such a decision would depend on the extent to which the appropriate Canadian price exceeds international prices, relative to the risks we would face as a nation if we increased our dependence on imported oil.

The federal government is fully aware of the interrelationships that exist between prices and fiscal systems in providing appropriate incentives to explore and develop. In this regard, the legislation concerning Canadian oil and gas land regulations that will be presented to Parliament this year and that will govern exploration and development activity in areas falling within federal jurisdiction, will impose only a nominal royalty and provide a substantial degree of flexibility. There will be provision for even this nominal royalty to be waived

in cases where it would make production uneconomic, but there will also be provision for a greater government share in the case of large and productive discoveries that turn out to be very profitable.

The rate at which domestic oil prices should reach the appropriate level is an issue that must be addressed by the federal and provincial governments, as well as by Canadians generally, in the context of current economic conditions. It is readily acknowledged that increases in oil prices result in substantially higher costs, especially for energy-intensive industries and for the agricultural sector. They contribute to inflation, create hardships for many Canadian consumers, and raise the possibility that the international competitive position of some Canadian industries may be adversely affected. But, if we do not continue our phasing to appropriate prices in a measured way, if we postpone taking reasonable steps when we have the opportunity to do so, then we lose the advantage of being able to manage the necessary transition to higher prices in the least disruptive way. We run the risk of being forced to accept larger price increases that could adversely affect our economic health at a time in the future that might be inopportune.

The provincial retail price freezes of the type which some provinces imposed after the July 1975 price increase for crude oil will be a source of difficulty should they occur again. At that time the Government of Canada recommended that product price increases be delayed for 45 days, on account of inventory stocks purchased at lower prices. Some consuming provinces imposed longer price freezes, one of which lasted 138 days. Others imposed no additional price restraints beyond the recommended 45 days. The situation that resulted compromised the single-price oil policy, led to inequities among provinces and regions of Canada, and caused severe cash flow problems for certain companies in some provinces. A Royal Commission established by the Government of Ontario to examine, among other issues, the matter of oil inventories recently reported that a price delay of between 30 and 40 days would have been appropriate in the circumstances existing in that province at the time of the last oil price increase. On the basis of this report, and other relevant information, discussions between the federal government and the provinces, directed at determining an agreed "inventory delay", have recently taken place. It is the federal government's objective to arrive, through these discussions, at a system for treating inventories that will be equitable for both the petroleum industry and for Canadian consumers, and will be agreed prior to the oil price increase that will occur on July 1 of 1976.

With regard to natural gas, the federal government remains committed to removing any undervaluation of natural gas relative to crude oil within two to four years. In the light of our current and projected supply/demand position this pricing policy for natural gas appears appropriate at the present time. Over the longer term, however, it may be desirable to reexamine the basis for setting the price of natural gas. It will be necessary to ensure that natural gas remains competitive with other energy sources, and oil in particular. The precise

manner by which the price is determined must depend, however, on our future demands for natural gas relative to the supplies that become available in the context of our overall objective of attaining energy self-reliance.

The vast bulk of electricity generated is sold by provincial utilities according to pricing schedules that allow for the recovery of costs and, in most cases, for the provision of some expansion capital, thus reducing borrowing requirements. In view of the increasing importance which electricity will play in our future energy system, and in view of the large anticipated capital requirements that will be necessary to provide adequate electric system capacity, some provincial utilities and provincial governments are reexamining their pricing policies and load management techniques. This is being done with a view to the development of policies aimed at meeting anticipated demands with acceptable risk factors and generally more efficient systems, and with due regard to the need to encourage medium to long term substitution of electrical energy for more scarce forms, in an orderly manner. Careful evaluation will be required in order to determine whether pricing policies, which place a premium on electricity use at a time of total system peak demand, can result in a reallocation of electricity use over time that will allow a given demand to be satisfied more economically and reduce capital requirements. Any pricing changes introduced should be carefully considered, since customers may respond by installing costly equipment, such as storage heating devices, or by modifying process equipment. In addition, the increased costs associated with more sophisticated metering equipment made necessary by more selective pricing structures, would also need to be taken into account. A considerable amount of practical experience with selective pricing and load management techniques has been accumulated by European electric utilities and it may be possible to adapt such experience to Canadian conditions.

The Government of Canada is prepared to encourage such studies of pricing and load management techniques by sharing the cost of such demonstration projects as are deemed to be in the national interest.

Finally, as an important component of appropriate energy pricing the federal government reaffirms its commitment that energy exports will be sold at international prices or at commodity value in the markets to which they are being delivered.

2. Energy Conservation

- ***Specific Target:*** **To reduce the average rate of growth of energy use in Canada, over the next ten years, to less than 3.5% per year.**

The energy conservation program introduced in February 1975 constitutes an integral element of our national energy strategy, not only for the next ten years but over the longer term as well. Canadians use more energy per person than any other country in the world, with the exception of the United States.

In 1974 Canadians consumed the equivalent of 50 barrels of oil per person*. As well as having a relatively high level of energy use, Canada has experienced a very rapid increase in energy consumption. Our energy use has grown faster than our total production of goods and services and energy used per person has been growing at an increasing rate. Over the thirteen years from 1960-73 energy use per person increased by almost 4% per year. From 1970-73, it grew by over 4¼% per year.

There are many reasons why Canadians are high energy consumers. The Canadian climate; the vastness of our country and the large transportation demands such size imposes; the nature of our industrial, agricultural, and export base: all suggest that Canadians will require more energy than most other people with comparable standards of living. But there are other reasons why we use as much energy as we do and why our consumption has increased so rapidly. Energy has been readily available at prices that were relatively low and declining in real terms through most of this period. When Canadians made such basic decisions as where to live, what kind of house to buy, what kind of car to drive, where to build their plants, how to organize their industrial processes, etc., an important factor in these decisions was relatively low energy prices. As a result, a great deal of our current energy use is much more inefficient than it need be. Indeed, our attitude towards energy is unique for a northern nation. An observer would be hard put to identify many differences between lifestyles and construction in Canada and those in warmer climates.

The federal government's energy conservation program is designed to encourage efficiencies in the use of energy and, more generally, to reduce the rate at which Canadian energy requirements will grow in the future. The assumption that energy use must grow at a high rate to provide a continuously increasing standard of living and quality of life must be critically examined. Experience in other countries has demonstrated that similar standards of living are associated with very different levels of energy consumption. High rates of growth in energy demand could require major economic readjustments and the possible sacrifice of consumption of other goods and services in order to make labour and capital available to produce new energy, as well as having undesirable effects on our natural environment and on our cities. We could find that continued high rates of increase for energy consumption reduce, rather than enhance, the quality of our lives.

It is apparent that, even at current Canadian energy prices, we have reached the point where it is profitable for individuals and industries to make investments now to save energy in the future. As Canadian prices continue to increase, this incentive will become even greater. It is less obvious, but no less true, that

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* In 1971, the three most energy-intensive countries on a per capita basis were the United States, Canada and Sweden. Americans, on average, used about one third more energy than Canadians. The average Canadian used about 50% more energy than the average Swede.

as a nation we are at a point in time when it is less costly to save energy than to produce more of it. For example, recently introduced mileage standards for automobiles can result in a reduction of gasoline demand in 1985 to levels 20% below 1975 consumption, even after allowing for continued growth in the number of automobiles. The energy saving resulting from these new standards in 1985 could be equivalent to the annual output of two Syncrude-size oil sands plants at a capital cost in excess of $4 billion.

Reducing the rate of increase in energy demands to our target of less than 3.5% per year will reduce substantially the capital requirements that will be necessary to produce new energy—by billions of dollars. Our energy conservation program must continue to ensure that these savings occur.

With higher energy prices, it is perhaps surprising that additional measures are needed. In fact, of course, to a considerable extent conservation does occur in response to price, and this is reflected in the differences between the demand scenarios presented in Section III. However, conservation is not likely to proceed as far or as fast as desirable as a result of higher prices. For one thing, there are many instances in which the various parties to a transaction have different interests. For example, a designer wishes to erect a satisfactory structure at lowest initial cost whereas the later owner wishes to minimize operating costs. Energy guidelines are necessary in building codes to bring the efficiency incentives which face the operator to bear on the designer and builder. Second, over time in an expanding economy, numerous incentives have been built into our pricing and taxing system that reflect the ready availability and low price of energy experienced in the past. For example, we tend to encourage the use of primary rather than recycled materials. It is now time to consider whether incentives should shift more towards encouraging the use of recycled materials. Finally, consumers are faced with a bewildering variety of messages urging them to purchase various articles. It is necessary to provide some way of standardizing, or making consumers aware of, the energy efficiency of the goods they purchase and, in particular, major appliances. In addition, it may be desirable to prohibit or limit the use of certain products, such as disposable beverage containers.

Over the past year the federal government's program has consisted mainly of public information, consultation, and in-house changes. The response on the part of all Canadians has been encouraging. For example, most of the major energy-consuming industries in Canada are already reviewing opportunities for conservation, either on their own or in collaboration with the federal and provincial governments. As part of this effort, two federal conferences with industrial energy users have been held. At the second conference, in March of 1976, industry presented sector-by-sector targets for energy savings attainable over the next few years. Most of these targets ranged from 10-15% per unit of output. Initially the gains will be obtained from operational changes. Eventually, as new investment is undertaken, they will come from the installation of energy-conserving equipment and the adoption of energy-conserving processes.

In February of 1976 the Minister of Energy, Mines and Resources announced a number of new federal government initiatives directed at strengthening the energy conservation program. They are described below.

Automobiles: New mileage standards were introduced for automobiles sold in Canada. Each automobile manufacturer and importer with significant sales volume in Canada will be required to meet sales-weighted fleet-average targets of at least 24 miles per gallon by 1980 and 33 miles per gallon by 1985. This is to be accomplished without compromising the current emission standards for Canadian automobiles and will result in a lower level of total gasoline consumption in 1985 than in 1975. In addition, beginning in 1976 a listing of all new automobiles, ranked in order of fuel performance, will be compiled and published by the Ministry of Transport.

Buildings: Most Canadian houses, apartments, office and industrial buildings are inefficient in their use of energy. We use 30% of our total energy consumption in heating and cooling them. The Government of Canada has announced that new guidelines for the design, construction and operation of energy-efficient buildings of all sizes in Canada will be completed before the end of 1976. These guidelines will either be adopted as part of the National Building Code or in new federal standards. In addition, financial encouragement and assistance is being given for the improvement of existing residences, through the revision of existing loan and grant programs, to emphasize the purchase of insulation material and energy-saving equipment. The guidelines could cut energy consumption for new residences by 50% and for new commercial buildings by as much as 75%.

Appliances: Minimum energy-efficiency standards are being reviewed for furnaces and prepared for major home appliances and office equipment. These standards could result in energy savings of up to 20% on new appliances. In addition, an appliance-labelling program is being introduced. This will clearly identify the energy-efficiency of all major household appliances sold in Canada, and will enable consumers to consider lifetime operating cost of major appliances, as well as purchase price. It should promote both the design and purchase of more efficient appliances.

Industry: Existing industrial assistance programs are now being administered in a manner that supports energy conservation, including the recovery of waste heat.

Federal Government: Specific elements of the Government's in-house conservation program were announced in early 1975. The initiatives recently announced will strengthen this program by instituting energy conservation targets and reporting systems. Beginning in the 1976-77 fiscal year, all government departments and agencies have been asked to decrease their energy consumption by 10% and target to hold future energy use at that level for the next ten years. A monitoring and reporting system is being set up and the Minister of Energy, Mines and Resources will report to the public on the results of this program. In addition it has been decided that all federally-funded programs will follow the energy conservation guidelines established for federal buildings, and contain provision for energy auditing to ensure that energy conservation approaches are adopted.

In addition to the measures described above a number of studies are currently underway, directed at assessing the feasibility and the relative costs and benefits of such additional action as district heating, energy-efficient public transit, energy audits in industry, possible changes in the Income Tax and Excise

Tax Acts designed to encourage conservation, recycling of materials, improved air transport efficiency, and discouraging heavy automobiles. Certain of these areas will require consultation with and cooperation from provincial governments, many of which have established their own energy conservation programs. In addition, some provinces have taken action on their own to introduce new building codes, to reduce speed limits, to discourage the use of large cars and to promote the idea of conservation. Given the enormous costs of new electrical generating and gas supply systems, some provinces are reviewing their utility pricing practices, which to date have tended to encourage consumption rather than conservation. In sum, all governments recognize the necessity to conserve our energy resources and are committed to doing so. Conservation programs will continue to be extended and reinforced because they represent the most immediate, lowest-cost and lowest-risk means by which we can contribute to the achievement of our objective of energy self-reliance.

3. Increased Exploration and Development

- ***Specific Target:*** **To double, at a minimum, exploration and development activity in the frontier regions of Canada over the next three years, under acceptable social and environmental conditions.**

Decisions that must be taken with regard to future energy supply require an adequate understanding of the various options. This understanding depends critically on the extent of our knowledge about ultimate recoverable energy resources in Canada—their magnitude, location and anticipated costs.

With respect to oil and natural gas, it will be necessary to increase exploration activities in order to provide the information that will be required to make appropriate decisions. The estimates presented in connection with the scenarios described in Section III suggest that a reasonable exploration and development program could require about $40 billion, measured in dollars of 1975 purchasing power, over the next 15 years. Over the period from 1976-80, it is anticipated that we will need total exploration and development expenditures amounting to over $10 billion (in 1975 dollars), with exploration accounting for about 70% of this total. Exploration and development expenditures over the next five years will require, on average, a little more than $2 billion per year, even with no allowance for inflation.

It is important that a high level of activity be maintained particularly in the frontier regions of Canada and, in view of our self-reliance objective, in the East Coast offshore area. To assure that this occurs, the Government of Canada

- has established Petro-Canada, which will be capitalized to a total of $1.5 billion and will engage actively in frontier exploration; and
- will introduce to Parliament new legislation concerning Canadian oil and gas land regulations, which will reduce uncertainty by providing a stable fiscal and land tenure system, but which will also impose conditions aimed at the acceleration of exploration activity.

It is the federal government's view that, as domestic prices for oil and natural gas continue to increase towards the levels which will provide adequate incentive to produce frontier resources, the cash flow position of the industry will be sufficient to meet normal financial obligations and to undertake an exploration and development program on the scale described above. It will be necessary to monitor the use of industry cash flow very closely. *A new reporting system will be introduced and, should it become necessary, the Government of Canada will take action to ensure that an appropriate share of the industry's cash flow is used for exploration and development in Canada.*

A federal-provincial program has been launched recently in order to better delineate promising areas in Canada for uranium exploration. The uranium potential is so promising that Canada could well maintain its strength in the export market into the long-term future. Similarly, a number of federal-provincial programs are underway as part of the compilation of a National Coal Inventory.

4. Increased Resource Information

To plan effectively it is necessary to know what resources are available. One of the most serious problems facing the federal government in its efforts to elaborate energy policies that are appropriate, is the substantial degree of uncertainty that remains with regard to ultimately recoverable resources in the frontier areas of Canada. In the Beaufort Sea, and the offshore areas of the Arctic Islands and eastern Canada, large geological structures which may contain substantial reserves of hydrocarbons have been identified. It is difficult to develop appropriate energy policies without knowing whether these structures are full or empty, and this knowledge can be obtained only by drilling. Although recent developments on the Labrador Shelf have been promising, technological problems associated with developing and producing reserves which may exist are formidable. More complete information on the extent, location and nature of the hydrocarbon resources which may occur is required as rapidly as possible in order to assess the degree to which these potential reserves can be produced commercially.

The Government of Canada will introduce legislation providing the responsible Minister with the authority to require companies holding rights to such structures to have exploratory drilling undertaken within a reasonable time period. The legislation will contain appropriate safeguards for the companies concerned as well as appeal procedures. It will also contain appropriate penalties for those companies that do not comply. It will make possible, over a period of time, the receipt of information that is necessary to plan our energy future in the most beneficial way.

In addition, the federal government will reduce the period during which geological information remains confidential. Earlier release of such information will facilitate greater efficiency in exploration activity.

The Government of Canada has recently taken a number of steps, in co-operation with the provinces and independently, directed at increased information with regard to Canadian uranium and coal resources.

In September of 1974, in conjunction with the export policy for uranium that was announced at that time, a Uranium Resource Appraisal Group was established within the Department of Energy, Mines and Resources. This group is charged with doing an annual audit of Canada's uranium resources which are recoverable at prices up to twice the world market price for uranium at the time of assessment. The establishment of the Uranium Resource Appraisal Group has increased the detail and uniformity of resource assessment. The first report of this group was published in August of 1975*. In addition, the federal government, together with provincial governments, is conducting a continuing 10-year, $25 million reconnaissance program directed at the further delineation of Canadian uranium resources.

With regard to coal, several federal-provincial resource evaluation studies are being conducted as part of the National Coal Inventory: the Saskatchewan program is in the concluding stages; drilling is proceeding in Nova Scotia; drilling is expected to begin in the near future in New Brunswick; discussions are underway with the Province of Alberta on common standards and procedures for the reporting of coal inventory data; and discussions are in progress with the Government of British Columbia for the design and scheduling of comprehensive drilling and evaluation on the Dominion Coal Blocks and other coal deposits in that province. The appropriate development of Canadian coal resources, in terms of national energy objectives, provincial aspirations, and environmental safeguards, can be properly evaluated only with a thorough knowledge of what resources are available and in what manner they can best be developed and used. The Government of Canada, therefore, places a high priority on early completion of programs contributing towards improvement of the coal inventory of all regions of the country.

5. Interfuel Substitution

The encouragement of interfuel substitution, and of the potential for substitution in an emergency situation, constitutes an important element of the strategy of self-reliance, particularly in eastern Canada where we are heavily dependent on imported oil. The scenarios presented in Section III suggest that, under appropriate conditions, substantial opportunities to substitute domestic coal, electricity and possibly natural gas for imported oil could exist. In practice, however, substitution of one fuel for another may be quite difficult. The degree to which interfuel substitution can take place will depend on such factors as technological limitations, economic considerations, the user's perceptions as

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* *Assessment of Canada's Uranium Supply and Demand*, Energy, Mines and Resources, August, 1975.

to future availability of supplies, interprovincial cooperative planning, and the rate at which current energy-using equipment is being replaced.

To the degree that governments control the prices of oil and natural gas directly and exercise substantial influence on the prices of electricity and coal, pricing policy can be used to facilitate the substitution of one energy source for another. Indeed, the policy of pricing natural gas at "commodity-equivalent" value with crude oil has already resulted in substantial shifts away from natural gas, particularly in industrial use, and has thereby contributed to an easing of the potential supply/demand difficulties that were foreseen for natural gas. In a similar way, future pricing policies for natural gas should reflect, as well as the costs of production and transportation and a reasonable rate of return, a relationship to the price of oil that is appropriate in the light of the relative supplies of these energy sources and the desire to facilitate energy self-reliance through the encouragement of interfuel substitution.

Beyond the use of market forces to encourage interfuel substitution, there are a number of specific areas where government initiatives may be desirable. These include:

- encouraging substitution of electricity generated from domestic energy resources, including nuclear, hydro and coal, for electricity generated from imported oil;
- pursuing the potential for supplying natural gas to the Atlantic and Quebec markets from either northern or east-coast resources;
- encouraging substitution capability in the design of energy conversion systems, for example coal gasification and multifuel boilers for electricity generation and industrial process heat; and
- facilitating the use of renewable energy sources, such as solar and wind, that may not be initially competitive, including the encouragement and support of approved demonstration projects.

The federal government is supporting interfuel substitution through such initiatives as financial assistance for the Point Lepreau nuclear station in New Brunswick, the electrical interconnection to Prince Edward Island and an offer to assist in the further development of the Lower Churchill River in Newfoundland. In general terms, such specific measures must be evaluated on the basis of the additional costs they impose in relation to the degree to which they are effective in promoting the overall objective of our energy strategy.

The necessity to use our existing energy resources more efficiently is closely related to the question of interfuel substitution, particularly with regard to electricity where relatively large capital requirements are expected. The prospect of capacity expansion that may require between $90 and $130 billion, at 1975 prices, over the next fifteen years, suggests the necessity of attempting to find more efficient ways of supplying electrical energy demands with reduced capital requirements. In this regard the development of efficient heat pumps, the in-

vestigation of productive uses for low-grade heat (including district heating and industrial process heat), and the further strengthening of interregional electrical interconnections are areas that should be encouraged. Specific initiatives will require further study in cooperation with provincial governments, and such initiatives will be pursued.

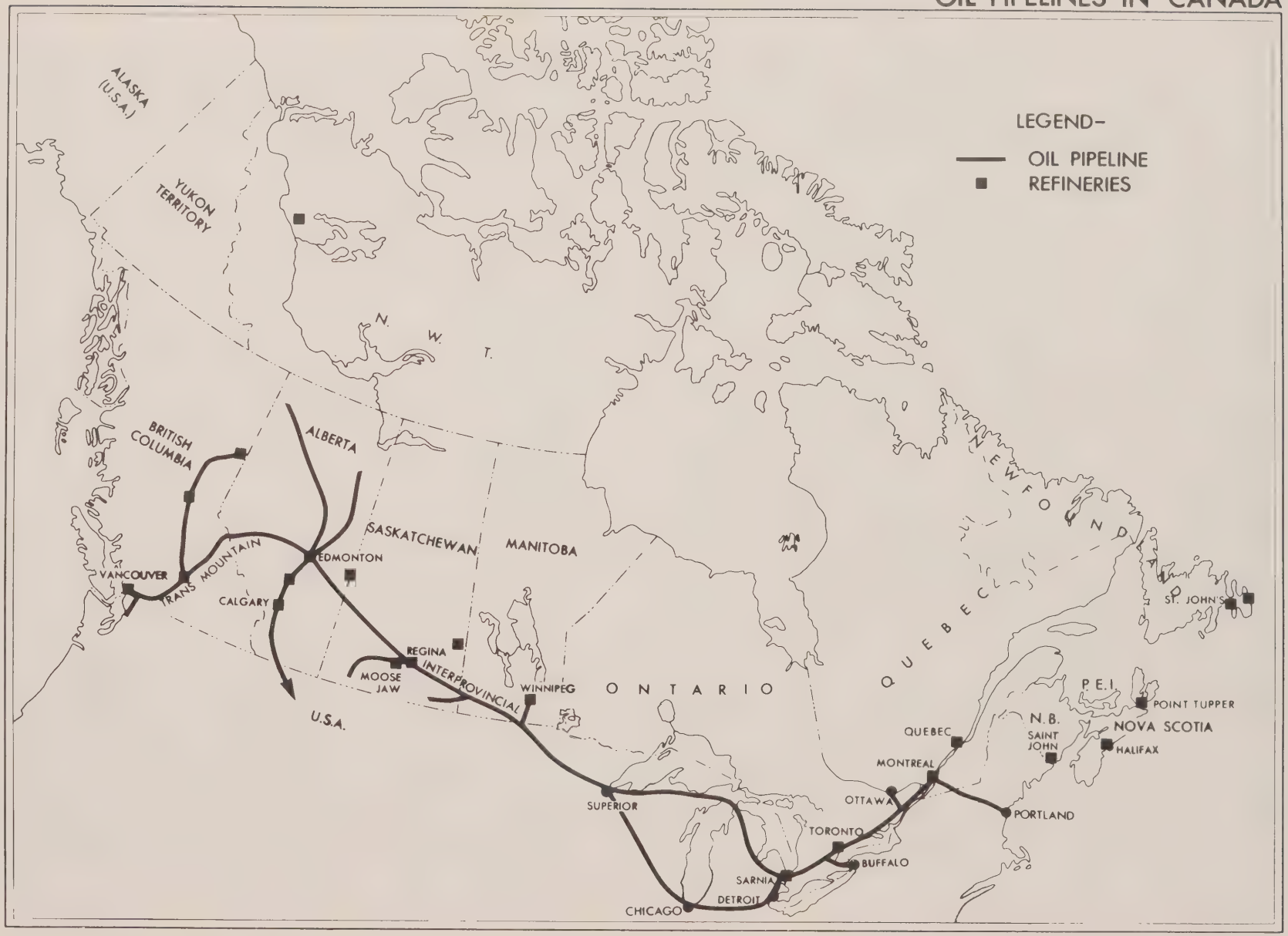
6. New Delivery Systems

With the extension of the Interprovincial Pipe Line system to Montreal, western Canadian oil is expected to begin flowing to the Montreal market in the spring of 1976. This pipeline provides the capability to deliver 250 000 barrels per day to Montreal, with the potential to increase this flow by an additional 100 000 barrels/day if required. A throughput of 350 000 barrels/day is roughly equivalent to 45% of the oil imported into eastern Canada in 1975. As the demand for oil in eastern Canada increases and the availability of Canadian supplies diminishes it may become necessary to reverse the flow in this pipeline to deliver oil to Ontario markets. The precise date at which such a reversal could become necessary is uncertain at the moment, and will depend on the success of the policies we adopt to reduce our dependence on imported oil. It may, however, become necessary to increase our capability to deliver oil to Montreal, possibly Canadian oil from the eastern Arctic or the East Coast offshore, through a further extension of the Canadian pipeline system to the east coast.

Applications for two competing natural gas pipelines from the Mackenzie Delta to southern markets are currently being heard before the National Energy Board. The Canadian Arctic Gas Pipelines (CAGPL) proposal is for a 48-inch-diameter line that would tie into Prudhoe Bay reserves and trans-ship U.S. natural gas from Alaska through Canada to U.S. markets. The Foothills Pipe Lines Ltd. project proposes a 42-inch-diameter line to deliver only Canadian gas to Canadian markets. The hearings before the National Energy Board are examining resource availability, supply of and demand for natural gas, contracting arrangements, engineering considerations, financing plans and a variety of items related to the public interest, including such areas as economic impact, environmental considerations, and Canadian content.

Because of the far-reaching implications of pipeline development for Canada's northern areas and native peoples, the Government of Canada appointed a Mackenzie Valley Pipeline Inquiry commission in March of 1974. The commission is headed by the Honourable Mr. Justice T. R. Berger and is in the process of inquiring into the terms and conditions that should be imposed on a northern pipeline in view of the social, environmental and economic impact on the region, and taking into account the socio-economic and environmental Guidelines for Northern Pipelines tabled in the House of Commons by the Minister of Indian and Northern Affairs on June 28, 1972.

OIL PIPELINES IN CANADA



GAS PIPELINES IN CANADA

In addition to these two proposals, which are currently being reviewed by the National Energy Board and the Berger Commission, the Polar Gas Project, formed in late 1972, has been investigating the feasibility of systems to deliver natural gas from the Arctic Islands. The Governments of Canada and Ontario have recently provided financing to facilitate these feasibility studies. The results to date suggest that a natural gas pipeline could be technically feasible and environmentally acceptable, but the economics have yet to be investigated in a detailed way. They will depend critically on the costs incurred in overcoming a number of difficult technological problems and in the availability of sufficient geographical concentrations of reserves.

Proposed routes for the CAGPL and Foothills projects, as well as possible routes for the Polar Gas pipeline are indicated on the accompanying map.

It is clear from the supply and demand scenarios presented in Section III that the prospect of substantial supplies of natural gas from Canada's frontier areas offers great potential for alleviating Canadian energy supply/demand difficulties and facilitating the reduction of imported oil through the next fifteen years. At the same time, however, the costs, including the social and environmental costs, associated with as rapid a development as possible of northern gas must be determined before any final approval for pipeline construction can be granted.

The Government of Canada is not committed to the delivery of frontier gas at any cost. The reports to be submitted by the Berger Commission and the National Energy Board will provide information necessary to assess the options available. On the basis of this information the Government will determine the timing and means by which northern resources might be developed to best serve the national interest.

In order to be prepared for the possibility of natural gas shortfalls, and to provide for the equitable distribution of supplies that may not be adequate to meet Canadian demands and current contractual export commitments, the Government of Canada will introduce amendments to the National Energy Board Act. These amendments will facilitate the allocation of domestic natural gas supplies among consuming provinces in the event of shortages. In addition, consultations with U.S. officials will be pursued to determine the manner in which such shortages, should they occur, would be shared between domestic and export customers.

In January of 1974, the Minister of Energy, Mines and Resources announced that the Government of Canada would pay 50% of the cost of approved studies relating to interprovincial or interregional electrical interconnections and finance up to 50% of the capital cost of approved projects. Strengthened regional electrical interconnections, leading to a form of integrated national system, would permit the more efficient growth of the connected systems, mutual assistance in the event of power failures, and some averaging out of peak and off-peak loads. They would economize on the need for stand-by power and facilitate the more rational growth and development of the electricity supply industry.

In view of the potential capital requirements of the electrical sector over the next fifteen years, and in view of the objective of minimizing Canadian dependence on imported oil, the federal government believes that the strengthening of regional power interconnections, particularly in eastern Canada, should be accelerated and that closer coordination in the joint planning and development of power projects by provincial utilities should be pursued.

In 1974, Ontario consumption of coal accounted for about 50% of total Canadian consumption. The bulk of Ontario requirements have traditionally been supplied under long-term contracts with mines located in the United States, but the future use of coal in Ontario, to its full potential, will require increasing reliance on Canadian sources. Canadian coal resources are such that substantial potential exists for interfuel substitution, particularly with regard to industrial use and electrical generation in central Canada. The degree to which such substitution can take place, however, will depend on the provision of transportation facilities adequate to deliver western Canadian coal to markets in central Canada.

The present transportation system is capable of handling up to one million tons of coal per year (about 6% of current requirements in central Canada) through an iron ore terminal at Thunder Bay which is the principal bottleneck of the system. During the latter half of 1974, Ontario Hydro carried on negotiations with the railway companies for track improvements between Alberta and British Columbia and the Lakehead, and with a consortium for the construction of the first stage of new coal terminal facilities. These facilities were to be capable of handling 3 million tons per year by 1977, with expansion to 12 million tons per year ultimately foreseen. However, one of the key elements of the arrangement was a guaranteed minimum traffic to the railways, necessary to facilitate their required capital expenditures. It has not been possible to provide this guarantee pending Alberta approval for the development of the mining properties involved and consequently the proposed schedule has been delayed.

It is clear that it is necessary to improve the transportation systems for eastward movement of western Canadian coal, and that proposed delivery systems be efficient and competitive. It is also apparent that improved delivery systems will depend, to a large degree, on the conclusion of contractual arrangements between Canadian producers and consumers of coal. The federal government therefore takes the position that, before new export commitments for coal are undertaken, efforts should be made by the producers to determine whether a market exists in Canada for the additional coal production. The province of Alberta has lent its support to this policy.

7. Emergency Preparedness

A major element in planning our energy future over the next ten years must be an acceptable degree of emergency preparedness, in the event of possible curtailments of international oil supplies. Beyond taking appropriate action to

reduce the degree to which Canada relies on imported oil, it will be necessary to assure that Canadians are protected against interruptions in the supply of oil we continue to import.

The scenarios presented in Section III indicate that net oil imports in 1985 might amount to 950 000-1 200 000 barrels per day. Average usable inventories of crude oil and products are estimated to be about 100 million barrels, which would be equivalent to about 80-100 days supply of net imports in 1985. Through the next few years, with lower levels of import exposure, these inventory stocks provide a significant degree of protection against selective embargoes or general supply curtailments. This protection is further augmented by standby production in western Canada, the Sarnia-Montreal pipeline, an emergency allocation program developed by the Energy Supplies Allocation Board, and participation in the emergency sharing scheme of the International Energy Agency.

Under the IEA emergency sharing scheme, the Participating Countries have each agreed to:

- maintain oil stocks sufficient to sustain normal consumption for at least 70 days with no net imports of oil (expected to increase to 90 days by 1980); and
- maintain a contingency program of demand restraint measures.

In the event of an emergency reduction in the oil supply to one or more of the Participating Countries, the cooperative sharing scheme* is automatically triggered and, in general terms, works in the following manner:

- the sharing of any shortfall up to the mandatory demand restraint level is *based on oil consumption* and it will not exceed 10% of oil consumption;

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* The main elements of the sharing scheme are as follows:

(a) For a shortfall in oil supplies up to 7% of normal consumption each Participating Country handles the situation by any means it chooses.

(b) Should the shortfall exceed 7% of the normal consumption of the group of IEA countries, each Participating Country is expected to reduce its oil consumption by 7% by means of its contingency demand restraint measures. This reduced level of consumption is maintained in each Participating Country by all countries drawing down their emergency reserves at rates proportional to their normal net imports. The actual imports available to the group are then allocated to bring each country's oil supplies up to its normal consumption level less the 7%.

(c) Should the shortfall exceed 7% of normal consumption in one or more of the Participating Countries, but be less than 7% for the group, the affected Participating Countries are only required to reduce their consumption by 7%, and the remaining shortfall is met through allocation of oil supplies from the other Participating Countries in proportion to their normal consumption.

(d) Should the shortfall exceed 12% of normal consumption of the group of IEA countries, each Participating Country is expected to reduce its oil consumption by 10%.

- the sharing of any shortfall in excess of this 10% level is *based on net oil imports*. It is therefore apparent that Canada has a significant degree of security since imports roughly balanced exports in 1975, whereas total net imports to the IEA group are about 22 million bbls/day.
- Canada's total exposure to a supply curtailment would amount to 10% of demand, or about 175 000 bbls/day. To the degree that standby production capability exists, and transportation can be arranged to eastern Canada, increased production of western Canadian oil can be used to satisfy the demand restraint criteria. With respect to transportation, the 1976 completion of the extension of the Interprovincial Pipe Line system to Montreal will facilitate the movement of increased amounts of domestic crude oil to eastern Canada in an emergency.

It is also apparent, however, that Canada's relatively favourable position under the IEA sharing scheme will be eroded as our standby production is used up and we become net importers. If, by 1985, we can achieve our objective of limiting net oil imports to one third of our total consumption we will be required under the terms of our treaty commitment to maintain emergency reserves of the order of 60-70 million barrels. This must be regarded as a minimal target for Canada. Although it appears that average usable inventories in Canada—which are in the order of 100 million barrels of crude oil and products—would be adequate to satisfy our international treaty commitment, it may nevertheless be desirable to increase our emergency storage capability further to augment the degree of protection afforded to Canadian users of imported oil. The federal government has a number of new projects under consideration and discussion with provincial governments, including below-ground storage in facilities such as the salt strata in Nova Scotia and the Wabana iron mine in Newfoundland, which has a potential storage capacity of about 100 million barrels. In addition, serious attention has been given to alternative emergency precautions, including the maintenance of allocation plans that have been prepared and the development of fuel switching capability.

The negotiation of long-term bilateral supply contracts for oil has been urged as a desirable measure to safeguard supplies in an emergency. While long-term contracts may be advantageous for other reasons, they would not provide as much additional emergency protection as might seem the case, since our obligations under the IEA would require that the oil so procured be shared with other countries should shortfalls occur.

8. Increased Research and Development

Science and technology have a multiple role to play in a national strategy. There are, in addition to the continuing and increasing needs for scientific data and analysis in resource assessment and in policy planning, great opportunities for science and technology in developing new energy systems, improving existing ones and in limiting the demand for energy. Perhaps most significant of all the

contributions of science and technology to a national strategy is the potential offered for providing new energy options in the future.

The successful realization of the promise of safe, economic and indigenous nuclear power is evident in Canada today and is clearly the result of identifying the potential of the nuclear science in the past. What other options can be contributed by increased efforts in energy research and development? What priorities should be set? These are the questions to which the federal government has been seeking answers.

Reducing demand and interfuel substitution are areas where science and technology can make contributions. High priority must be given to research and development which will increase our supplies of oil and gas, including enhanced recovery from known oil and gas fields, in situ recovery methods from the oil sands, and the development of new technology for the frontier region. The decline of coal as a major source of energy must be reversed, and in this respect new methods of mining, environmental protection, transportation and utilization must be developed. Coal gasification is an obvious area for significant scientific development.

At an early stage in the search for new options, the renewable resources, represented by tidal, solar, wind, geothermal and biomass, were identified, as was power from nuclear fusion, as areas where the application of science has great potential. It is recognized that their major contribution will be over the long term, and their impact will not be substantial in the next ten to fifteen years. We can use this time to develop a coordinated program, which will assess all contending forms of renewable energy and fully develop the most promising and economically feasible forms for future application.

A review of the federal effort in energy research and development reveals a total expenditure of $113 million during fiscal year 1975-76 on energy research and development, three quarters of which was devoted to the nuclear field. The remainder was widely distributed through different departments and agencies on the many other facets of energy. Although the funds for nuclear research and development are clearly justifiable and essential for a program of the magnitude of CANDU, the potential offered by research and development on other energy forms has yet to be fully funded. The Government of Canada has therefore designated six major priority areas or tasks to be emphasized over the next few years and has decided that resources be gradually increased to elevate these activities, some of which were seriously under-funded and ineffective, to make them viable programs capable of offering significant contributions to solving the nation's energy problems. More recently the federal government has approved limited additional funding for fiscal year 1976-77, as part of a policy of incremental support over the next five years. The task areas designated are presented in Table 17, with present and proposed levels of additional funding. They are listed in order of priority for additional funding, except for transport and transmission of energy which would receive a priority corresponding to the form of primary energy involved.

Table 17

Research and Development Priorities and Expenditures

Energy R & D Task	*Expenditures ($ millions)*	
	1975-76	*Additional 1976-77*
Conservation	8.6	1.8
Oil and gas	10.5	1.5
Coal	2.8	2.5
Nuclear (including uranium resources)	84.8	1.1
Renewable*	1.6	1.0
Transportation and transmission	4.9	1.7
Total	113.2	9.6

* Hydro and tidal, solar, wind, geothermal and biomass.

The federal energy research and development program is coordinated by the recently established Interdepartmental Panel on Energy Research and Development, chaired by a senior representative of the Department of Energy, Mines and Resources and supported by an Office of Energy Research and Development (OERD), within the department. All new funding for energy research and development will be approved by the Panel which will play a major role in the process of program forecasting for energy R & D.

Other forms of cooperation and coordination are also needed in energy R & D. Many energy resources are under provincial jurisdiction and the results of energy R & D programs will most often be applied by provincial utilities or private industry. It is essential therefore that both the provincial governments and industry be involved at an early stage in federal programs. To this end, shared programs are being developed with provincial authorities in such areas as resource assessment, uranium reconnaissance surveys, coal gasification, oil sands, and electrical transmission. Participation of the private sector is being promoted at present through contracts and through consideration of "unsolicited proposals" from industries. Additional ways of involving industry will be explored as programs develop.

A final consideration in this vital area of cooperation is the appropriate degree of coordination between Canadian research and development programs and similar programs in other countries. It makes little sense to duplicate large-scale programs that are taking place elsewhere. At the same time, however, it is necessary to maintain an early-warning system for worldwide scientific and technological developments that may become relevant to Canada's needs, and to concentrate Canadian programs in areas where we have a particular advantage or particular problems that need to be overcome. In this regard

Canada has participated actively in the research and development program of the International Energy Agency. The Agency is sponsoring cooperative activities in a number of areas, including coal technology, solar energy, radioactive waste management and nuclear safety. The Government of Canada is participating with other interested IEA governments in implementing agreements related to coal technology and will consider participating in similar agreements that may be developed.

9. Greater Canadian Content and Participation

In the elaboration of the strategy proposed for the next ten years, the Government of Canada is committed to higher levels of Canadian content and participation in resource development. The scenarios dealing with future capital requirements of the energy sector, discussed above, suggest that Canada must continue to rely substantially on foreign capital in the future. The Foreign Investment Review Agency will have the responsibility of determining that future screenable foreign investments are of significant benefit to Canada.

In addition, greater Canadian content and participation will be reinforced by:

- legislation concerning Canadian oil and gas land regulations to be introduced to Parliament shortly which will facilitate greater Canadian participation in exploration and development of Canada Lands;
- the entry of Petro-Canada into exploration and development;
- uranium ownership policy, under which foreign participation in new uranium developments is limited to 33%;
- guidelines with regard to Canadian content in resource-related activities on Canada Lands, particularly with respect to engineering and project management at the development stage.

Chapter 4. A NATIONAL ENERGY STRATEGY: TARGETS

Together with the objective and policy elements of the national energy strategy, the Government of Canada has adopted the following targets:

(i) To move domestic oil prices towards international levels; and to move domestic prices for natural gas to an appropriate competitive relationship with oil over the next 2-4 years.

Domestic energy prices must continue to increase, to reinforce efficiency and restraint in energy use; to encourage the development of additional Canadian supplies; to reduce the magnitude of the transfer of real wealth from Canadians to oil-exporting countries; and to reduce the subsidization of oil consumers by the general taxpayer. They need not move to international oil prices if it is clear that new Canadian resources can be found and delivered to markets at prices that are lower.

(ii) To reduce the average rate of growth of energy use in Canada, over the next ten years, to less than 3.5% per year.

This can be attained by appropriate pricing measures and energy conservation initiatives. It represents a reduction of the historically observed growth rate by over one third. It is a reduction which is technically feasible with a minimal impact on our standard of living and quality of life. It is a reduction which is essential if we are to be able to plan our energy future in the most appropriate way. Over the next year or two, as the performance of the Canadian economy accelerates, the growth in energy consumption may exceed 3.5% per year. As we approach steady economic growth at potential and as the results of energy conservation initiatives take effect, it is expected that the rate of growth of energy consumption will fall below 3.5% per year.

(iii) To reduce our net dependence on imported oil in 1985 to one third of our total oil demands.

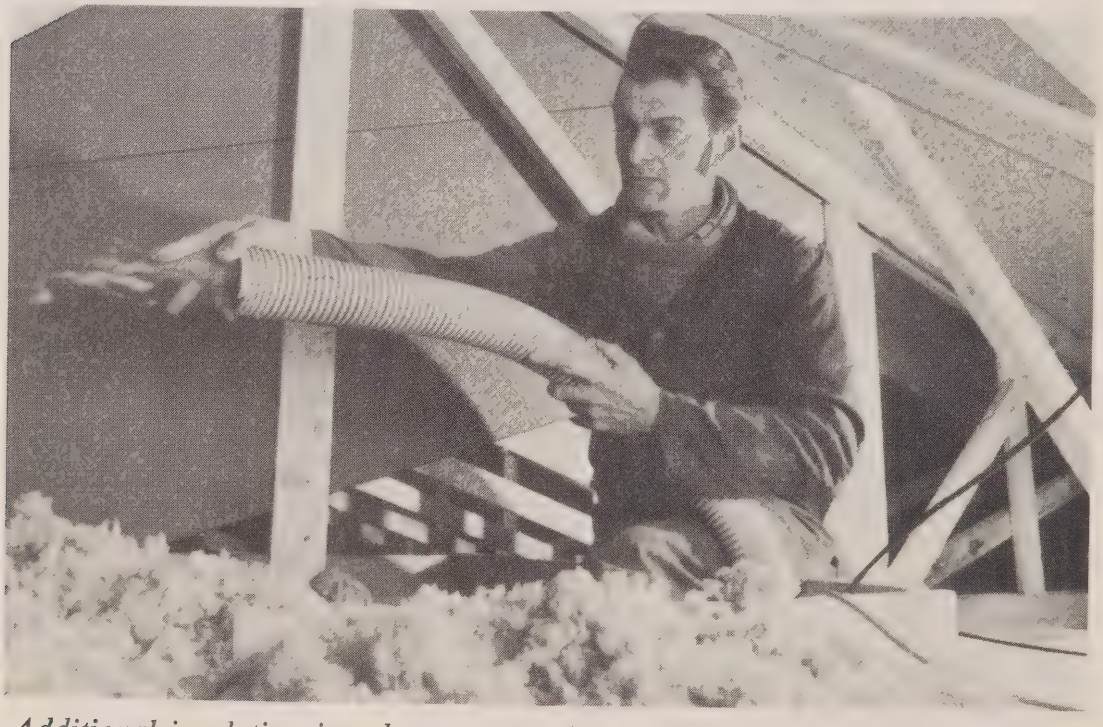
In 1975 average oil imports into Canada were about 890 000 barrels/day, over 50% of total oil consumption. Taking account of oil exports we were roughly in balance in 1975. In 1977 total imports should drop to about 700 000 barrels/day, because of the Sarnia-Montreal pipeline but total exports will decline as well so that net imports could average about 240 000 barrels/day. As our exports continue to decline and our demands continue to increase our *net* dependence on imported oil will also increase. The scenarios in Section III suggest that, in the absence of new government initiatives, *net* imports of oil may amount, by 1985, to between 950 000 and 1.2 million barrels/day, or 40% to 47% of total oil demand. Through competitive pricing, increased exploration and development, interfuel substitution, and strong energy conservation programs, the federal government sets a target of reducing Canadian dependence in 1985 to one third of Canadian demands.

(iv) To maintain our self-reliance in natural gas until such time as northern resources can be brought to market under acceptable conditions.

The analysis presented above suggests that there is a prospect of natural gas shortages, if not in the late 1970's then in the early to mid-1980's. The extent and timing of possible shortages will depend in large measure on natural gas prices. While it may be possible and desirable to deliver northern gas to southern markets in the early 1980's, there are a number of outstanding questions, now being assessed, with regard to the environmental and social impact of northern pipeline development and the anticipated cost of northern gas resources. Governments will have to act through appropriate natural gas pricing, energy conservation, interfuel substitution and increased exploration and development in the western provinces to avoid natural gas shortages until a decision on the timing of northern pipelines that best serves the national interest can be taken.

(v) To double, at a minimum, exploration and development activity in the frontier regions of Canada over the next three years, under acceptable social and environmental conditions.

This is a minimal target that will facilitate the development of the information necessary to make appropriate decisions about our energy options. In 1975 exploration and development expenditures in the frontier are estimated at about $350 million. At least a doubling will be achieved by an active role for Petro-Canada and more rigorous land and lease obligations. Appropriate energy pricing will generate the cash flows required to at least meet this target. New reporting systems will be introduced and, if necessary, the federal government will take appropriate steps to ensure that the industry invests an appropriate portion of these cash flows on exploration and development activity in Canada.



Additional insulation in a home can reduce heating costs considerably.

Chapter 5. CONCLUSION

Our energy problems are complex. We have reached a point where the structure of our energy system is changing in ways that will deeply affect present as well as future generations of Canadians.

In 1975, Canadians used almost 8 000 trillion Btu's of primary energy—the equivalent of about *3.75 million barrels of oil per day*. Energy use has increased in Canada at about 5.5% per year over the past fifteen years.

It is evident that our recent energy history has been characterized by a growth that, barring major and currently unforeseen technological advances, is not sustainable. If we were to assume, for example, that the demands for energy in Canada were to continue to grow at 5.5% per year, then in the year 2000 energy demands would amount to the equivalent of *14.3 million barrels of oil per day*. In a period as short as 25 years our annual use of energy would have increased by a factor of about four. How would these demands be met? There is no easy answer but a hypothetical illustration is revealing. If we assume that we could double our current hydroelectric capacity and, as well, construct on average four new Pickering-size nuclear stations *each year* for the next 25 years, at the end of the century we would still require other energy forms to supply almost 40% of our energy demands. If we were to rely on fossil fuels to make up this gap, then we would be using such fuels in the year 2000 at an annual rate twice as great as we are now.

This example is presented to illustrate a basic fact that all of us must comprehend: there is no single solution. We must strive to reduce our energy requirements to the minimum necessary to support the quality of life we desire. We must accelerate the search for new sources of energy and for new technologies for the production, distribution, conversion and utilization of energy. We must intensify our efforts to maintain control of our energy future, by minimizing our dependence on sources of supply that are not secure. And, mindful of the social, environmental and economic aspirations of all Canadians, we must pursue these aims in a manner that makes the necessary adjustments as smooth and orderly as possible.

This is the challenge. It is a tough challenge, but we believe the strategy we have set forth will meet it positively and effectively. It is a strategy directed towards self-reliance, both short-to-medium and long term. Further policy initiatives—directed at the problems of transition from oil- and gas-based energy systems to alternative energy sources—will be required to prepare for the longer-term future. For both the short-to-medium term and the longer term, however, the next ten years are critical.

With the constructive cooperation of provincial governments and industry, and with the support of Canadians in all regions of the country, Canada can achieve the objective of energy self-reliance. Success in this endeavour will increase both the confidence and the options with which we can plan for the years beyond 1985.

ANNEXES

Annex I. CHRONOLOGICAL LISTING OF POLICY INITIATIVES, 1973-1976

1973

March —Crude oil export controls announced.

June —Export controls instituted for most petroleum products.

—"An Energy Policy for Canada—Phase 1" published.

August —Policy on uranium enrichment announced.

September —Price restraint program for crude oil and petroleum products initiated.

—Government's intention of extending Interprovincial Pipeline to Montreal announced.

October —Crude oil export charge established.

—An energy supply contingency plan was established, in light of curtailed international production and selective embargoes.

December —A bill to establish an Energy Supplies Allocation Board was introduced in the House of Commons. It was subsequently approved by Parliament in January of 1974.

—The Prime Minister placed before the House of Commons a proposal to set the basis for a new national oil policy to include a national market for oil with a single price, the establishment of a national oil company, the extension of the oil pipeline to Montreal, and intensification of research on oil sands technology.

—A bill to provide for the imposition of an export charge was introduced in the House of Commons and was approved in January of 1974. The charge rose from 40 cents in October of 1973 to $6.40 in February of 1974.

1974

January —The federal government announced a policy of an all-Canadian coast-to-coast pipeline network to develop self-reliance in oil and details of the Interprovincial Pipeline extension to Montreal.

—First Ministers' Conference on Energy held. In addition to discussing the matter of an oil price increase, the federal government announced programs of assistance to encourage the expansion of electrical production based on nuclear energy and the interconnection of provincial utilities to ensure greater efficiency and security. A policy statement was

1974 (*cont.*)

January (Cont.) also made concerning the protection of uranium reserves for the domestic market, further processing requirements, stockpile use, and on support for uranium exploration.

—The Oil Import Compensation Program became effective on January 1 to provide for a single crude oil price across Canada subject only to transportation and quality differences.

—Establishment of an Office of Energy Conservation within the Department of Energy, Mines and Resources, to develop and recommend a program of energy conservation and to play a coordinating role among all institutions and authorities who would have responsibilities in conservation efforts.

—Establishment of an Office of Energy R & D within the Department of Energy, Mines and Resources to review, assess and coordinate the activities of the federal government in Energy R & D.

March —First Ministers' Conference reconvened and agreement was reached on a price increase to $6.50 a barrel from $3.80, effective April 1.

—Mr. Justice Thomas R. Berger was appointed by the Government of Canada to inquire into, and report upon, the terms and conditions for a right-of-way that may be granted for a natural gas pipeline to cross Crown Lands in the Northwest Territories and the Yukon.

September —The federal government announced a decision, based on a report of the National Energy Board, to establish a border export price for natural gas of $1.00/Mcf, effective January 1, 1975.

—The Minister of Energy, Mines and Resources issued a major uranium policy statement on September 5 setting out the terms under which uranium exports would be permitted having regard to future Canadian requirements and the adequacy of reserves to meet those requirements.

November —Federal budget dealt with fiscal arrangements related to petroleum industry (see Annex II).

—The Minister of Energy, Mines and Resources announced the findings of the National Energy Board with respect to the exportation of oil and the federal government's decision to accept the Board's findings that steps should be taken to reduce exports of oil with a view to providing additional protection for Canadian requirements.

—Throughout 1974 Canada participated in international preparations leading to an "Agreement on an International Energy Program" creating the International Energy Agency (IEA) under the auspices of the Organization for Economic Co-operation and Development. The Agreement was signed in November 1974 and came into effect in January 1976.

December —The Minister of Energy, Mines and Resources announced more stringent safeguards in respect of the sale abroad of Canadian nuclear technology, facilities and material.

1975

February —The Governments of Canada, Alberta and Ontario reached an agreement with the three private participants of Syncrude Canada Limited to form a new partnership to continue to build and to operate the Syncrude plant.

—The Minister of Energy, Mines and Resources announced an energy conservation program for Canada.

—Another in a series of oil price guidelines was announced, to provide in this case provision for oil companies to recover non-crude cost increases.

March —Agreement was reached between the federal government and Interprovincial Pipe Line Limited covering the construction of a crude oil pipeline extension from Sarnia to Montreal.

April —A First Ministers' Conference on Energy was held on April 9-10 but no consensus was reached as to the timing and amount of the next crude oil price increase.

—The Petroleum Administration Act was passed by the House of Commons on April 30 and subsequently by the Senate and received Royal Assent in May.

May —The Minister of Energy, Mines and Resources announced further changes with respect to the pricing of natural gas exports to the United States. Prices were to rise to $1.40/Mcf effective August 1, 1975 and to $1.60 effective November 1.

June —The Federal Budget provided for the increase in the crude oil price to $8.00/barrel, from $6.50; a special 10 cent excise tax on motor gasoline for non-commercial use; the increase to $1.25/Mcf effective November 1, 1975, of the Toronto city-gate price of Alberta natural gas; and an increased tax incentive to those companies that increased exploration activities.

—Canada/United States understanding was reached on oil "swapping" arrangements.

July —Federal government oil price guidelines were announced to provide for an increase in the wholesale price of oil products, equivalent to the $1.50/barrel increase in crude oil, effective 45 days following July 1 when the crude oil price increase became effective.

—The Minister of Energy, Mines and Resources commented on the recently issued National Energy Board report on natural gas demand, supply and deliverability which drew attention to the fact that natural gas supplies would not be adequate in the near term to meet both projected increases in domestic demand and existing export commitments.

—The Oil Import Compensation Program was amended so that compensation for crude oil imports would be paid on a flat rate basis rather than using rates varying with crude type, source and landing points.

1975 (*cont.*)

July (cont.) —Legislation to establish a National Petroleum Company, Petro-Canada, was approved by Parliament.

—The Minister of Energy, Mines and Resources announced that the federal government had approved participation by Petro-Canada in the Polar Gas Study Group.

August —The National Energy Board announced that hearings on the Mackenzie Valley Pipeline applications would commence on October 27.

September —The National Energy Board issued its second oil export report.

—An agreement on natural gas pricing and on the flowback to producers of extra revenue from gas at the higher export price was reached between the federal government and the Government of Alberta.

November —The natural gas city-gate price of $1.25 per Mcf in the eastern zone, as announced in the June budget, took effect on November 1.

December —Canada, as co-chairman, played an important part in the launching of the Conference on International Economic Co-operation (CIEC) and is participating directly in the work of the two commissions dealing with energy and development.

—An Energy Ministers' Conference was held on December 12 on energy supply and demand, conservation, pricing and energy research and development.

1976

January —Petro-Canada began operations on January 1.

—Negotiations were concluded by Canada and United States officials on the text of a Pipeline Agreement which was then referred to the respective governments for review and approval with a view, in due course, to signature and ratification.

February —Minister of Energy, Mines and Resources announced a number of new energy conservation programs including mileage standards for automobiles sold in Canada, energy-efficiency guidelines for buildings, minimum energy standards for appliances, support of energy conservation through existing industrial assistance programs and lower energy consumption by federal departments and agencies.

March —An Energy Ministers' Conference was held on March 5 to discuss oil and gas pricing, treatment of oil inventories, oil industry financing, energy conservation, northern pipelines, and the International Energy Agency.

—Minister of Energy, Mines and Resources announced new funding for energy research and development.

—The federal government announced that, as an interim measure pending the National Energy Board's hearing and decision on Interprovincial Pipe Line Limited's system tolls, it would meet the cost of shipping western Canadian oil from Toronto to Montreal.

Annex II. EVOLUTION OF FISCAL SYSTEMS

1971 —Canadian income tax system reforms included provisions to reduce and make more efficient the relative tax advantages of investment in the petroleum industry. Automatic depletion (equal to one third of taxable production income) was replaced, beginning in 1977, by "earned" depletion, whereby companies would have to earn the right to deduct up to one third of their production profits by continuing to explore and develop. Every $3 of exploration and development expenditure would earn $1 of depletion deduction. Oil and gas income was not to be subject to the lower federal tax rate proposed for mining income effective 1977, but oil and gas royalties (unlike provincial mining taxes) were to continue to be fully deductible as an expense for federal income tax purposes.

January 1973 —The Mineral Taxation Act of Alberta came into force. Its new royalty structure distinguished between "old" and "new" production, and effectively increased the average royalty rate on oil from 16% to 22%. It introduced a tax on freehold reserves and increased royalty rates on natural gas to a maximum of $16\frac{2}{3}$%. Freehold producers were given an option to pay the mineral tax on reserves or the royalty on production. These fiscal arrangements were to last for a five-year period.

October 1973 —Alberta announced that its royalty system introduced in January would be overhauled. Saskatchewan increased its volumetric royalty on crude oil and announced its intention to levy a royalty surcharge of about 83% on future price increases. Together with the average royalty rate of about 17% in that province, this action implied that the Government of Saskatchewan would collect virtually 100% of any further increase in Canadian oil prices.

Late 1973 —The Government of British Columbia increased its royalty rates on oil and established the British Columbia Petroleum Commission which, through the assumption of the bulk of the contracts of Westcoast Transmission and other B.C. gas carriers, would appropriate most of any future increase in natural gas prices. Royalties on the small volumes of gas not under contract to B.C.P.C. were raised to approximately 25% up to 20¢/Mcf and 50% on prices in excess of 20¢/Mcf.

January 1974 —The Petroleum Marketing Act adopted by the Government of Alberta set up a provincial marketing board to control production, marketing and pricing of Alberta oil and natural gas.

Early 1974 —Alberta raised its royalty rates on natural gas to 50% of the price between 36¢ and 72¢ per Mcf, and 65% of the price in excess of 72¢/Mcf. Royalty rates on oil were also restructured so that the provincial government would collect 65% of the price in excess of $4.41 per barrel.

May 1974 —The Minister of Finance introduced a budget that contained a number of measures to deal with the erosion of the federal tax base

that had occurred and to guarantee a reasonable share of petroleum industry revenues for the federal government, on behalf of all Canadians. The Government was defeated in the House of Commons in May and no action with regard to those proposals then took place.

November 1974 — Following the consequent election and subsequent discussions with the provinces and the industry, a further budget was brought down, reintroducing some of the measures in the May budget in revised form. This budget:

- raised the general rate of corporation income tax on resource profits from 46% to 50%, but introduced a special abatement from federal tax which, together with the provincial abatement of 10%, would reduce the net federal rate of tax from petroleum profits from 36% to 30% in 1974, 28% in 1975 and 25% thereafter;
- made royalties, taxes and other like payments to provincial governments non-deductible for income tax purposes;
- accelerated the replacement of automatic depletion by earned depletion, from January of 1977 to May 1974, and reduced the maximum annual depletion from one third to one quarter of production profits; and
- reduced the allowable rate of claiming development expenditures from 100% to 30%, although the right to write off 100% of exploration expenditures was not changed.

December 1974 — The Premier of Alberta announced a major program to spur exploration and development principally within Alberta. The tax burden on the petroleum industry was reduced, and the program was estimated to reduce Alberta revenues by about $2.5 billion over the period 1975-79. The main elements of the program were:

- refund of that portion of the Alberta Corporation Tax arising because of the non-deductibility of royalties;
- refund of the federal corporation tax arising because of the non-deductibility of royalties, to a maximum of $1 million;
- increased drilling subsidies;
- increase of the "select price" for oil from $4.41 to $4.71 (this is the price above which higher royalty rates apply; as it increases the average effective royalty rate is reduced); and
- reduction of the supplementary royalty for natural gas, on that portion of the price above 72¢/Mcf, from 65% to 50%.

— Saskatchewan also introduced measures to rebate a portion of the increased tax liabilities arising from the non-deductibility of royalties.

June 1975 — The Government of Canada introduced two modifications to the taxation system for petroleum to take effect in 1976. The special

tax abatement introduced in November was to be replaced by a resource allowance, by which companies could deduct 25% of their adjusted production income. This resource allowance recognized the special position of the provinces in respect of resources and met, to a degree, the request for some form of deductibility of provincial levies. Since the resource allowance was based on production profits before the deduction of exploration and development, it also increased the incentive to explore and develop. At the same time, the corporation tax rate was reduced from 50% to 46%, the same rate applying to most other corporate activity; the net federal tax rate, because of the withdrawal of the resource abatement, increased from 25% to 36%, but it now applied to a lower tax base. These changes reduced slightly the anticipated federal share of resource revenues and increased substantially the incentives to explore for and develop new petroleum resources.

July 1975 —Alberta reduced its effective royalty rate for oil from 65% to 50%, on that portion of the price between $6.50 and $8.00.

—Saskatchewan revised basic and premium wellhead prices by 56-64¢/bbl and provided for a further 50¢/bbl mineral tax deduction from production on freehold land.

Summer 1975 —British Columbia introduced an exploration incentive scheme for natural gas and oil and lowered the royalty rate on oil.

October 1975 —The Government of British Columbia introduced a tax-indemnification scheme whereby it paid federal tax on deemed royalties on behalf of producers, to have effect retroactive to May 6, 1974.

November 1975 —The Government of Saskatchewan announced its intention to replace the existing agglomeration of legislation and regulation with a single system related to productivity and to institute a new oil royalty which would raise producers' returns. These measures are expected to be implemented in mid-1976.

Annex III. CANADIAN ENERGY FACTS AND FIGURES

Table 1. Estimated Petroleum Supply and Consumption, 1975
2. Sources of Canadian Energy Consumption
3. Canadian Energy Consumption
4. Petroleum Supply and Demand
5. Marketable Gas Supply and Demand
6. Coal Supply and Demand
7. Electricity Supply and Demand
8. Canadian Trade in Energy Commodities
9. Canadian Energy Capital Expenditures
10. Oil and Gas Energy Use by Consuming Sector and Region of Canada—1973

Table 1

Estimated Petroleum Supply and Consumption, 1975

(Millions of barrels per day)

	Canada	*U.S.A.*	*Japan*	*Western Europe*	*OPEC**	*Other*	*Western World***
Supply:							
Production	1.6	10.5	—	.5	27.1	3.8	43.5
Imports	.9	6.2	4.5	11.8	—	4.1	.9
Total	2.5	16.7	4.5	12.3	27.1	7.9	44.4
Demand:							
Consumption	1.7	16.5	4.5	12.3	1.5	7.9	44.4
Exports	.8	.2	—	—	25.6	—	—
Total	2.5	16.7	4.5	12.3	27.1	7.9	44.4

Net Imports:	Canada	.1
	U.S.A.	6.0
	Japan	4.5
	Western Europe	11.8
	Other	4.1
		26.5
	From eastern Europe and China	.9
	From OPEC	25.6

*Of which OAPEC production was 18.3 million barrels/day.
**World except eastern Europe and China

SOURCES: "Oil and Gas Journal"; "Oil and Energy Trends"; *International Petroleum Encyclopedia 1975*; "Petroleum Intelligence Weekly"; Department of Energy, Mines and Resources.

Table 2

Sources of Canadian Energy Consumption

(*percentages*)

	1960	*1965*	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*
Petroleum	48.6	49.4	48.1	48.2	47.7	47.3	46.3	45.9
Natural Gas	9.0	13.1	16.5	17.2	18.2	18.3	18.5	18.4
Coal and coke	14.7	13.0	10.7	9.7	8.6	8.5	7.8	7.7
Hydro electricity	27.7	24.5	24.6	24.3	24.5	24.0	25.6	26.6
Nuclear electricity	—	—	0.1	0.6	1.0	1.9	1.8	1.4
Total Btu's	3 671	4 814	6 328	6 534	7 056	7 481	7 770	7 867

Units: 10^{12} Btu's.
Natural gas: 1 000 000 Btu's/Mcf.
Hydro and nuclear electricity: 10 000 Btu's/ kilowatt-hour.
SOURCE: EMR estimates.

Table 3

Canadian Energy Consumption

(*percentages*)

	1960	*1965*	*1970*	*1971*	*1972*	*1973*
Domestic and farm	24.4	22.9	20.8	20.6	20.7	19.1
Commercial	8.5	11.2	14.1	14.3	15.2	13.0
Industrial	34.3	33.1	32.2	31.7	31.6	33.7
Transportation	25.5	24.7	24.3	24.4	24.5	25.5
Energy supply industries (including pipelines)	7.3	8.1	8.6	9.0	8.0	8.7
Total Btu's (excluding thermal)	2 920	3 789	4 971	5 135	5 468	5 732
Thermal energy (Btu's)	119	323	528	570	600	639

Units: 10^{12} Btu's.
Electricity at 3 412 Btu's/kilowatt-hour.
SOURCE: Statistics Canada, *Detailed Energy Supply and Demand in Canada*, Cat. 57-207.

Table 4

Petroleum Supply and Demand

(*thousands of barrels per day*)

	1960	*1965*	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*
Supply								
Production								
Crude and equivalent	532.0	876.1	1 382.1	1 476.0	1 698.4	1 962.9	1 843.3	1 623.1
Plant liquefied petroleum gases	11.4	46.5	94.0	108.3	133.1	153.1	151.3	157.0
	543.4	922.6	1 476.1	1 584.3	1 831.5	2 116.0	1 994.6	1 780.1
Imports								
Crude	343.1	395.0	568.9	671.1	769.6	883.7	797.7	844.5
Refined products	96.2	162.5	193.3	158.6	147.9	123.6	86.4	46.3
	439.3	557.5	762.2	829.7	917.5	1 007.3	884.1	890.8
Total	982.7	1 480.1	2 238.3	2 414.0	2 749.0	3 123.3	2 878.7	2 670.9
Demand								
Domestic demand	860.0	1 144.6	1 466.3	1 516.5	1 619.6	1 711.2	1 738.7	1 748.4
Exports								
Crude and equivalent	113.0	295.6	669.8	750.8	951.3	1 148.0	907.0	707.3
Liquefied petroleum gases	—	21.1	57.0	64.4	85.5	98.9	100.2	95.1
Other refined production	9.9	8.6	36.2	52.1	116.4	149.8	134.7	115.6
	122.9	325.3	763.0	867.3	1 153.2	1 396.7	1 141.9	918.0
Stock change	(0.2)	10.2	9.0	30.2	(23.8)	15.4	(1.9)	4.5
Total	982.7	1 480.1	2 238.3	2 414.0	2 749.0	3 123.3	2 878.7	2 670.9

SOURCE: EMR estimates.

Table 5

Marketable Gas Supply and Demand

(*billions of cubic feet*)

	1960	*1965*	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*
Supply								
Production	443.0	1 051.0	1 868.6	2 071.8	2 362.1	2 520.8	2 498.9	2 520.2
Imports	5.5	17.7	10.9	14.3	15.7	14.8	13.3	10.9
Total	448.5	1 068.7	1 879.5	2 086.1	2 377.8	2 535.6	2 512.2	2 531.1
Demand								
Net sales	320.7	575.5	924.0	1 008.6	1 157.0	1 238.4	1 323.1	1 348.7
Pipeline uses[a]	11.3	55.1	118.9	118.5	127.7	129.9	116.2	101.7
Exports[b]	109.8	404.7	780.2	912.2	1 009.7	1 028.0	959.2	946.9
Reprocessing	—	21.4	29.3	49.8	74.8	80.9	78.1	85.0
Stock change	6.7	12.0	27.1	(3.0)	8.6	58.4	35.6	48.8
Total	448.5	1 068.7	1 879.5	2 086.1	2 377.8	2 535.6	2 512.2	2 531.1

NOTES: [a]Includes pipeline fuel consumed in Canada to move gas for export, which has been excluded from projections of domestic requirements.

[b]Includes pipeline fuel consumed in U.S.A. to move gas to central Canada.

SOURCE: EMR estimates.

Table 6

Coal Supply and Demand

(*millions of short tons*)

	1960	*1965*	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*
Canadian production	11.0	11.5	16.6	18.4	20.7	22.6	23.3	27.7
Imports*	12.7	16.7	19.8	18.4	19.4	17.3	14.3	18.1
Domestic demand	22.5	25.8	28.3	27.9	26.7	27.6	27.4	28.0
Exports*	1.0	1.3	4.7	8.0	9.7	11.7	11.9	13.4
Net exports	(11.7)	(15.4)	(15.1)	(10.4)	(9.7)	(5.6)	(2.4)	(4.7)

* Includes coke.

SOURCE: EMR estimates.

Table 7

Electricity Supply and Demand

(*billions of kilowatt-hours*)

	1960	*1965*	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*
Canadian production	114	144	205	216	240	263	279	273
Imports	1	4	3	3	2	2	2	4
Domestic demand	109	144	202	213	232	248	266	266
Exports	6	4	6	7	11	17	15	11
Net exports	5	—	3	4	9	15	13	7

SOURCE: EMR estimates.

Table 8

Canadian Trade in Energy Commodities

(*millions of dollars*)

	1960	*1965*	*1970*	*1971*	*1972*	*1973*	*1974*	*1975*
Crude oil and equivalent								
Exports	94.5	280.0	649.1	787.4	1 007.5	1 482.1	3 406.8	3 051.5
Imports	280.3	312.5	415.3	541.3	681.0	941.0	2 646.5	3 307.7
Balance	(185.8)	(32.5)	233.8	246.1	326.5	541.1	760.3	(256.2)
Refined products								
Exports	9.3	10.0	44.0	63.4	140.5	207.2	359.2	321.4
Imports	115.5	160.0	185.4	184.1	185.4	192.3	325.0	273.1
Balance	(106.2)	(150.0)	(141.4)	(120.7)	(44.9)	14.9	34.2	48.3
Liquefied petroleum gases								
Exports	0.0	10.8	37.5	46.0	62.9	93.1	244.2	300.8
Imports	0.0	0.8	1.8	1.0	1.3	2.3	2.3	2.3
Balance	0.0	10.0	35.7	45.0	61.6	90.8	241.9	298.5
Natural gas								
Exports	18.1	104.2	206.0	250.7	306.8	350.7	493.6	1 092.2
Imports	1.6	7.5	5.1	7.0	7.6	7.8	5.8	7.5
Balance	16.5	96.7	200.9	243.7	299.2	342.9	487.8	1 084.7
Coal and coke								
Exports	11.2	14.0	35.7	94.7	112.9	176.7	264.2	493.6
Imports	80.4	134.8	164.2	173.6	196.3	181.4	344.2	576.3
Balance	(69.2)	(120.8)	(128.5)	(78.9)	(83.4)	(4.7)	(80.0)	(82.7)
Electrical energy								
Exports	15.5	16.9	34.4	48.2	67.9	109.2	174.6	104.3
Imports	0.5	14.3	13.9	14.8	11.1	7.0	5.2	11.8
Balance	15.0	2.6	20.5	33.4	56.8	102.2	169.4	92.5
Radioactive ores								
Exports	0.0	53.7	26.0	17.7	40.1	64.2	54.9	45.3
Imports	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Balance	0.0	53.7	26.0	17.7	40.1	64.2	54.9	45.3
TOTAL								
Exports	148.6	489.6	1 032.7	1 308.1	1 738.6	2 483.2	4 997.5	5 409.1
Imports	478.3	629.9	785.7	921.8	1 082.7	1 331.8	3 329.0	4 178.7
Balance	(329.7)	(140.3)	247.0	386.3	655.9	1 151.4	1 668.5	1 230.4

SOURCE: Statistics Canada, *Imports and Exports by Commodities*, Cat. 65-007, 65-004.

Table 9

Canadian Energy Capital Expenditures

(five-year averages and percentage shares)

Industry	*1956-1960*		*1961-1965*		*1966-1970*		*1971-1975*	
	(millions of dollars)	*(%)*	*(millions of dollars)*	*(%)*	*(millions of dollars)*	*(%)*	*(millions of dollars)*	*(%)*
Crude petroleum and natural gas industry	240.3	17.6	355.0	26.5	524.9	21.2	1 027.2	22.1
Petroleum and natural gas transportation systems	176.7	12.9	124.2	9.2	214.8	8.7	343.8	7.4
Petroleum refining and marketing	152.2	11.1	92.8	6.9	218.5	8.8	452.0	9.7
Natural gas utilities	69.7	5.1	70.7	5.3	100.7	4.1	157.1	3.4
Electric utilities	647.5	47.4	691.3	51.6	1 350.6	54.7	2 580.7	55.4
Coal and uranium mining	80.2	5.9	6.3	0.5	61.0	2.5	92.1	2.0
Total energy	1 366.6	100.0	1 340.3	100.0	2 470.5	100.0	4 652.9	100.0
Total economy	8 465.0		10 074.8		16 118.4		27 664.3	
Energy share (%)	16.1		13.3		15.3		16.8	

SOURCE: Statistics Canada, *Private and Public Investment in Canada*, Cat. 61-205.

Table 10

Oil and Gas Energy Use by Consuming Sector and Region of Canada—1973

	Percentage of Sector Energy Supplied by Specified Fuel						
	Res.	*Comm.*	*Indust.*	*Trans.*	*Total Secondary*	*Electrical Generation*[1]	*Barrels*[2] *of Oil Equiv./ Capita*
Oil							
Atlantic	88	76	64	100	84	46	40
Quebec	74	59	55	100	74	1	29
Ontario	52	33	16	99	48	1	22
Manitoba	42	15	21	99	49	2	20
Saskatchewan	48	9	14	100	42	2	21
Alberta	28	8	12	100	32	1	25
B.C.	46	31	34	100	50	13	24
Canada	58	37	31	100	55	5	26
Natural gas							
Atlantic	—	—	—	—	—	—	—
Quebec	6	5	9	—	4	—	2
Ontario	29	39	41	—	27	8	13
Manitoba	40	52	44	—	32	3	13
Saskatchewan	41	65	67	—	48	28	26
Alberta	60	75	75	—	62	48	55
B.C.	34	41	29	—	30	10	16
Canada	25	34	32	—	25	8	13
Oil and natural gas							
Atlantic	88	76	64	100	84	46	40
Quebec	80	64	64	100	78	1	31
Ontario	81	72	57	99	76	9	35
Manitoba	81	68	65	99	81	5	33
Saskatchewan	88	74	80	100	90	30	48
Alberta	88	83	88	100	93	49	80
B.C.	79	72	63	100	80	23	40
Canada	82	72	63	100	80	12	39

1 Fuel used to generate electricity assumed to be converted at 34.12% efficiency.

2 Includes all oil and natural gas purchased for the generation of electricity.

SOURCE: Statistics Canada, *Detailed Energy Supply and Demand in Canada*, 57-207, 1973.

Annex IV. GLOSSARY OF TERMS

Abbreviations

EMR —Department of Energy, Mines and Resources.
NEB —National Energy Board.
IEA —International Energy Agency.
OECD —Organization for Economic Co-operation and Development.
bbl —barrel.
Btu —the amount of heat required to raise the temperature of one pound of water 1°F.
Quad —equal to 1 000 trillion B*tu*'s.
Mcf —one thousand standard cubic feet.
Bcf —one billion (one thousand million) standard cubic feet.
Tcf —one trillion (one thousand billion) standard cubic feet.
KW/kWh —Kilowatt/kilowatt hour.
/MW —Megawatt (1 000 kilowatts).
MM —million.
10^{12} —1 000 000 000 000 or trillion.

Definitions

CANDU: The nuclear reactor system known as CANDU, which is derived from CANada, Deuterium and Uranium, signifying that it is a Canadian concept, uses deuterium (heavy water) as the moderator and that the fuel is natural uranium.

City-gate price: That rate charged for natural gas by a long-distance transmission pipeline to a distribution company in a particular city or area, e.g. Toronto city-gate price.

Constant dollars: Synonymous with "in real terms", refers to dollars of constant and specified purchasing power; that is, adjusted for the effects of inflation, usually represented by the Consumer Price Index.

Energy self-reliance: As used in this document means supplying domestic demands from domestic energy resources to the greatest extent practicable in the light of economic, environmental and social considerations and, further, assuring that adequate protection exists to safeguard Canadian energy requirements that are met from imported supplies in the event of supply interruptions. It is further elaborated in Chapter 2 of Section IV.

Energy self-sufficiency: Supplying domestic requirements for each energy source completely from domestic energy resources *or*, alternatively, producing at least as much energy as is consumed, even though a portion of domestic demand may be supplied from imports (self-sufficiency in total energy).

Energy system: The set of interrelationships that characterizes the manner in which energy commodities are produced, converted to useful form, transported and utilized.

Frontier areas: Generally the offshore areas (east, west and Hudson Bay), the Arctic Islands (onshore and offshore) and the Mackenzie Delta-Beaufort Sea.

Fossil fuels: Any naturally occurring fuel of an organic nature, such as coal, crude oil and natural gas.

Fusion: The combining of certain light atomic nuclei to form heavier nuclei resulting in the release of energy.

Gross National Product (GNP): The total value of the goods and services produced in a nation during a specified period (as a year).

Heat pumps: A method of moving, concentrating or removing heat by alternatively vaporizing and liquefying a fluid through the use of a compressor. A reversible refrigeration system that can provide heat.

Hydrocarbons: Organic compounds containing carbon and hydrogen, characteristically comprising crude oil, natural gas liquids, natural gas, coal and bitumen, either naturally occurring or in a refined or semi-refined state.

In situ recovery: In place; the term in situ recovery refers to alternative methods of extracting oil from the deep parts of the oil sands, using heat, solutions, or related techniques, as opposed to mining methods.

LPG: Liquefied petroleum gases; propanes, butanes and propane-butane mixes.

Netback: Net return to a producer from a market sale.

Oil sands: In this document, the practice of the Alberta Energy Resources Conservation Board has been followed, which defines oil sands as sands and other rock materials which contain crude bitumens and all other mineral substances in association therewith. Crude bitumen is defined as a naturally occurring viscous mixture mainly of hydrocarbons heavier than pentane that may contain sulphur compounds and that in its naturally occurring viscous state is not recoverable at a commercial rate through a well.

Primary energy: Refers to the amount of energy available to the final consumer (secondary energy) *plus* conversion losses and waste used by the energy supply industries themselves. Conversion losses, in this case, refer to losses in processing of refined petroleum products for example, or the losses due to thermal and mechanical inefficiencies resulting from the conversion of fossil fuels (coal, oil or natural gas) into electricity in thermal power generation plants.

Real price: A price measured relative to prices of other goods and services, usually represented by the Consumer Price Index.

Reserve: That portion of the identified "resource" from which a usable energy commodity can be economically and legally extracted at the time of determination using currently available technologies.

Resource: Refers to all oil and gas, uranium or coal accumulations known or inferred to exist.

Resource base: In the context of this report, resource base refers to Canada's total potential domestic energy resources. Thus, the resource base includes currently proved and probable reserves and ultimate potential resources of oil, natural gas, coal, uranium, hydroelectric power and other forms of usable energy.

Secondary energy: (See primary energy).

Standby (or shut-in) capacity: This term is used in the oil- and gas-producing industry to mean the unused production capability of currently producing oil and gas

wells or shut-in oil and gas wells whether or not they are connected to the surface gathering and producing facilities, plus the known production capability of proved oil and gas pools not presently on production. The term thus implies the maximum reasonable production capability of all known oil and/or gas reserves without regard for their current production status or the availability of surface production facilities.

Wellhead: The equipment used to maintain surface control of a well. Also refers to various parameters as they exist at the wellhead: wellhead price of oil, etc.